POWER

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Standardization and Research

STANDARDS the use of which is mandatory must, in order to have any force in law, be established and promulgated by the constituted authority.

It is a fortunate thing for this republic that the several states relegated to the federal government the power "to coin money, regulate the value thereof, and of foreign coin, and fix the standard of weights and measures." The most confirmed opponent of governmental activity would not contest the necessity for the authoritative establishment of such standards and the enforcement of conformity with established values when such units are used.

The pity is that there cannot be still further centralization and reduction in the number of units in use for the same purpose.

Standardization in the use of these units is less distinctively a governmental function.

It is a matter of more than convenience to the public that articles of common use shall be uniform and interchangeable, but it has been the American policy to let the manufacturers and purveyors of such articles work out their own standards and voluntarily comply with them.

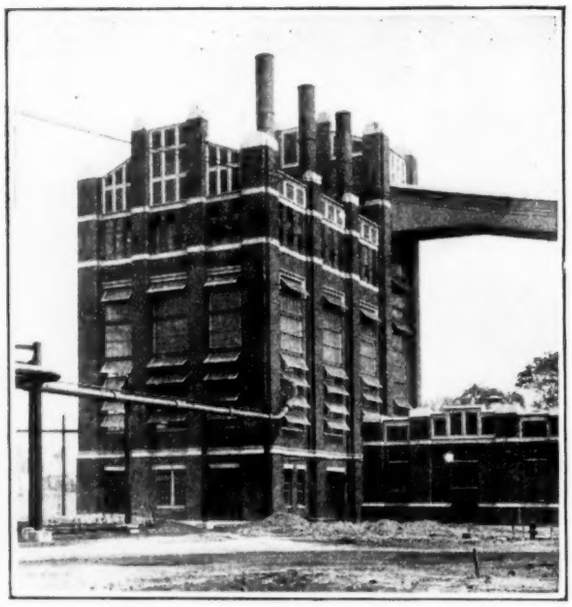
The establishment of the fundamental units is a comparatively simple matter, but it leads to research into the physical properties of materials and processes for their conversion to the use of men.

Such research is being done extensively by manufacturer's laboratories with especial reference to their own products, and they have, of course, a proprietary right in their own discoveries. But there are many such questions the solution of which is of public interest.

The Bureau of Standards, if given the necessary means, can be more than a national sealer of weights and measures. It has done and is still doing much to enlarge our knowledge of and to furnish precise values for the physical properties of the materials upon which our arts and industries and the users of their products are increasingly dependent. It should be encouraged in this broader activity. Everything that it determines or discovers is an asset to American industry and American living.

And the user pays for it and profits by it, whether it is discovered in a governmental bureau or a manufacturer's laboratory.

F. R. Low



Hunts Point Boilers Burn Coke Breeze

THE steam generated by the boilers of the Hunts Point byproduct coke plant is used for driving plant auxiliaries and for the coke byproduct processes.

IN PAST years unsettled conditions in the anthracite coal fields have caused various interruptions in the supply of this fuel to water-gas plants in the New York Metropolitan district. The bituminous coal supply is more stable, and in order to make this more reliable supply available for these gas plants, the Bartlett Hayward Co. designed and erected for the Consolidated Gas Co. a byproduct coke-oven plant at Hunts Point, New York City. The coke product of this plant is made to meet the requirements of water-gas plants, to which it is sold. A portion of the product of these ovens is coke breeze, which is not suited for use in the gas plants.

In order to use this cheap fuel, a boiler plant was constructed, designed to burn the waste coke breeze. Steam generated in these boilers is used to drive exhauster and blowing engines and pumps, and for processes in the byproduct plant requiring heat.

Sufficient steam-driven plant auxiliaries are provided so that the steam demand plus the steam used for byproduct processes requires the burning of all the coke-breeze product of the coke ovens. A number of the pumps and all the conveying and coke-oven equipment are electrically driven, the electric energy being purchased from the New York Edison Co.

The boiler plant consists of three 6,000-sq.ft. inclined water-tube boilers with horizontal drums. Steam is generated at 175 lb. pressure and superheated 100 deg. F. in bent-tube superheaters. The side walls of the furnaces are protected by fin-tube water screen walls, and in one boiler, as shown in the sectional elevation Fig. 2, the front and rear arches are water cooled, the tubes forming a support for the arch brick. The water and steam circulation in the wall tubes forms a part of the circulation in the boiler proper. Furnaces and stokers have been designed to permit operating the boiler at 300 per cent rating.

Feed water is heated in a combined deaërator and open heater to approximately 200 deg. F. and fed to the boilers by two 200-g.p.m. turbine-driven feed pumps. As an emergency precaution each boiler is equipped with a steam-operated feed-water injector. The feed to the boilers is controlled by automatic feed-water regulators.

Coke-breeze fuel is delivered from a coke sizing plant to the boiler house on a long inclined-belt conveyor capable of elevating 250 tons of fuel per hour. During the early stages of operation some trouble was experienced from occasional large pieces of coke mixed with the breeze, and it was found necessary to install a crusher to reduce all the coke to ½-in. size and smaller. A horizontal belt and automatic tripping device distributes the coke to a large bunker serving all three boilers. All the conveying equipment is electrically interlocked so that an emergency shutdown of one piece of conveying equipment will stop all other conveyors. This protection makes it impossible for coke to pile up at the entrance of a shut down conveyor.

An automatic feeder type weigher is installed at each boiler to measure the coke breeze fed to it. This device feeds the fuel into a bucket that automatically dumps into a hopper when 200 lb. of coke has been fed to it.

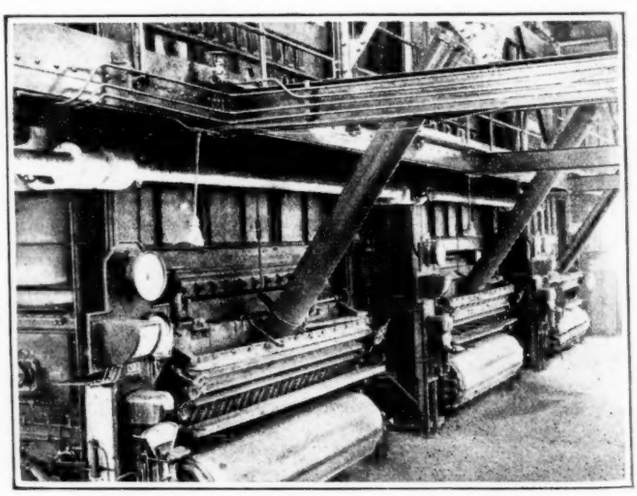


Fig. 1—Firing aisle, showing two 6,000-sq.ft. boilers in operation

A counter records the number of times the bucket is filled, and from this record the number of pounds of coke burned may be calculated. Approximately 60 tons of fuel is burned during a 24-hour period.

From the weigher the coke drops through a single 12-in. diameter spout to the stoker hopper, which is provided with a screw conveyor, one-half having a right-hand pitch, the other having a left-hand pitch. This conveyor, driven from the stoker engine, distributes the coke evenly in the hopper. At first trouble was experienced from a segregation of the coarse coke to the ends of the hopper while the fine material remained in the center. Changes in the speed and pitch of the screws have eliminated this difficulty.

The coke is burned on forced-draft chain-grate stokers each driven by a small reciprocating steam engine. The fuel bed is maintained thin, and most of the burning takes place under the opening between the front and rear arches. A large part of the air for combustion enters through the rear part of the grate and carries with it a considerable quantity of incandescent coke. This air and coke blast hits the low rear arch and is deflected down to the front of the furnace, where the incandescent and burning coke helps to ignite the incoming fuel. The front ignition arch and this ignition process are necessary to maintain the fire.

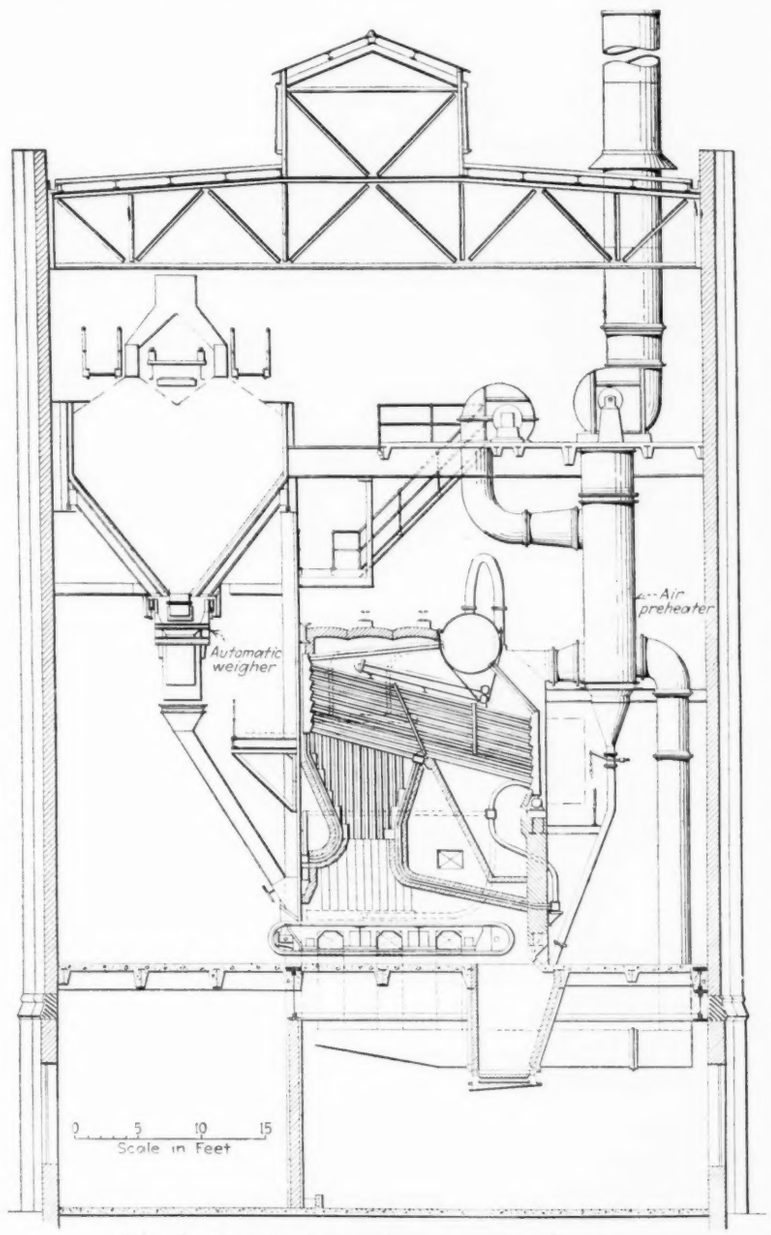


Fig. 2—Sectional elevation through boiler house

As the ash drops from the chain-grate stokers into the ash hopper, it is cooled by water sprays. Provision has been made for carrying off this cooling water, thus keeping the ash aisle dry and clean. Sufficient headroom has been provided so that the refuse can be dumped directly into motor trucks by opening gates at the bottom of the hoppers. These gates are controlled by oil-operated cylinders. Under present load conditions, the ash hoppers are emptied only once a day.

Air for supporting combustion is supplied by turbine-driven forced-draft fans and is preheated in plate-type air preheaters, one for each boiler. Individual ducts carry the air from the preheaters to each boiler. At 150 per cent rating the air is heated to about 225 deg. F. and the flue gas is reduced from 400 to 250 deg. F. Turbine-driven induced-draft fans draw the flue gas through the boilers and air preheaters, discharging to unlined steel stacks the tops of which are only 30 ft. above the boiler-house roof. Each boiler is served by one stack.

The 40-hp. turbines driving the induced-draft fans operate at 3,465 r.p.m. and drive the fans through reduction gears. The turbines for the forced-draft fans deliver 38 hp. at 2,030 r.p.m. and are direct-connected to the fans. Exhaust steam from these turbines together with the exhaust from the feed-pump turbines and stoker engines is used to heat the feed water in an open feed-water heater.

Hagan combustion control is used to regulate the forced- and induced-draft fans and to maintain balanced draft in the furnace. The stoker engines, however, are controlled by hand. Some trouble was experienced at first in finding the proper location for the draft connections used by the combustion control for maintaining balanced furnace pressure.

Each boiler is well equipped with instruments for aiding the firemen to operate the boiler properly. The individual boiler gage boards carry a steam-flow meter graduated in boiler horsepower, a multipointer draft gage, a CO_2 meter and a steam pressure gage. Other instruments (not shown in Fig. 1) record the flue-gas temperatures entering and leaving the air preheater and the air temperature leaving the preheater. A Venturi meter records and integrates the water fed to the boilers. In addition to the boilers burning coke breeze, there are 10 waste-heat vertical water-tube boilers each having 1,750 sq.ft. of heating surface. These boilers are located in a producer-gas plant and receive heat from the hot producer gas which is used to fire the coke ovens. The steam generated by these

boilers is largely used by turbine-driven fans that supply air for the gas producers and other fans that force the gas to the coke ovens. These boilers, however, are connected to the steam mains from the main boiler house and operate in parallel with the main boilers.

During the summer months only 10 per cent of the boiler-feed water is returned condensate, and 90 per cent is raw makeup from the city water mains. Because of this high percentage of makeup the boilers are blown

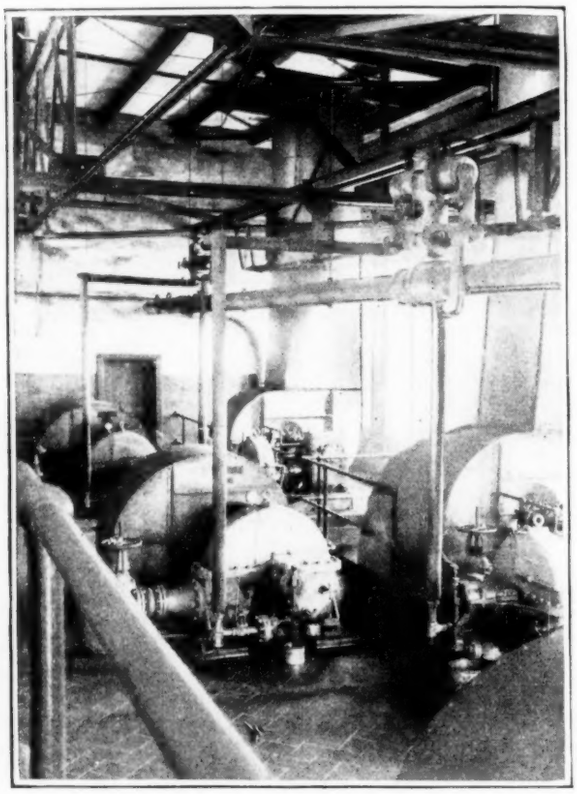


Fig. 3—Turbine-driven induced- and forced-draft fans

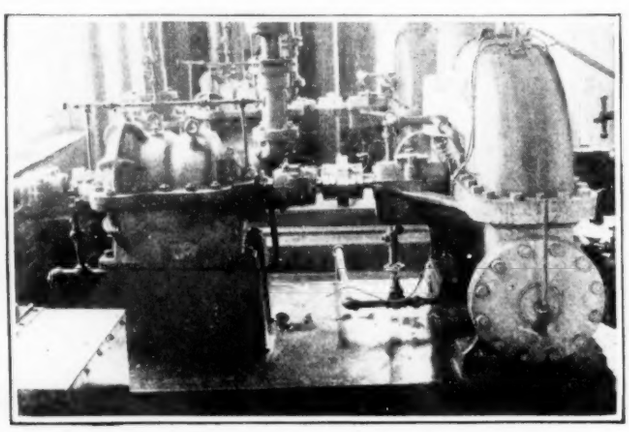


Fig. 4—Turbine-driven 200-g.p.m. boiler-feed pumps

down three times daily. Feed water is treated with tri-sodium phosphate.

Monthly operating data show that an average evaporation of 8.2 lb. of equivalent water per pound of coke breeze is being obtained. At present the heating value of the fuel is not determined and therefore efficiency figures are not available.

What Do You Know?

The answers are on page 362

MANY a man has acquired a reputation for brilliancy by a wise choice of audience and subject matter. By talking only on subjects with which he is familiar and never speaking save to those who know less, even a mediocre man can win fame. In fact, it is as essential to know what you do not know as it is to know what you know. But how much do you not know? Must the ten questions below be added to the list? The answers will enable you to set them under the proper heading.

Ques. 1—Who first suggested grounding low-voltage circuits as a protection? Should such circuits come in contact with high-voltage sources?

Ques. 2—Since a gasoline mixture will not explode unless at least 7 per cent and not over 15 per cent of the mixture is gasoline, why can the Diesel operate with so much lower a percentage of fuel in the mixture.

Ques. 3—Is it advisable to have a 2-in. air space in the brick walls of a horizontal-tubular boiler?

Ques. 4—Why is compression used in reciprocating steam engines?

Ques. 5—How is it possible to determine the weight of ammonia to be handled per ton of refrigeration, if the suction is in a saturated condition?

Ques. 6—How are oil leaks in turbine piping stopped?

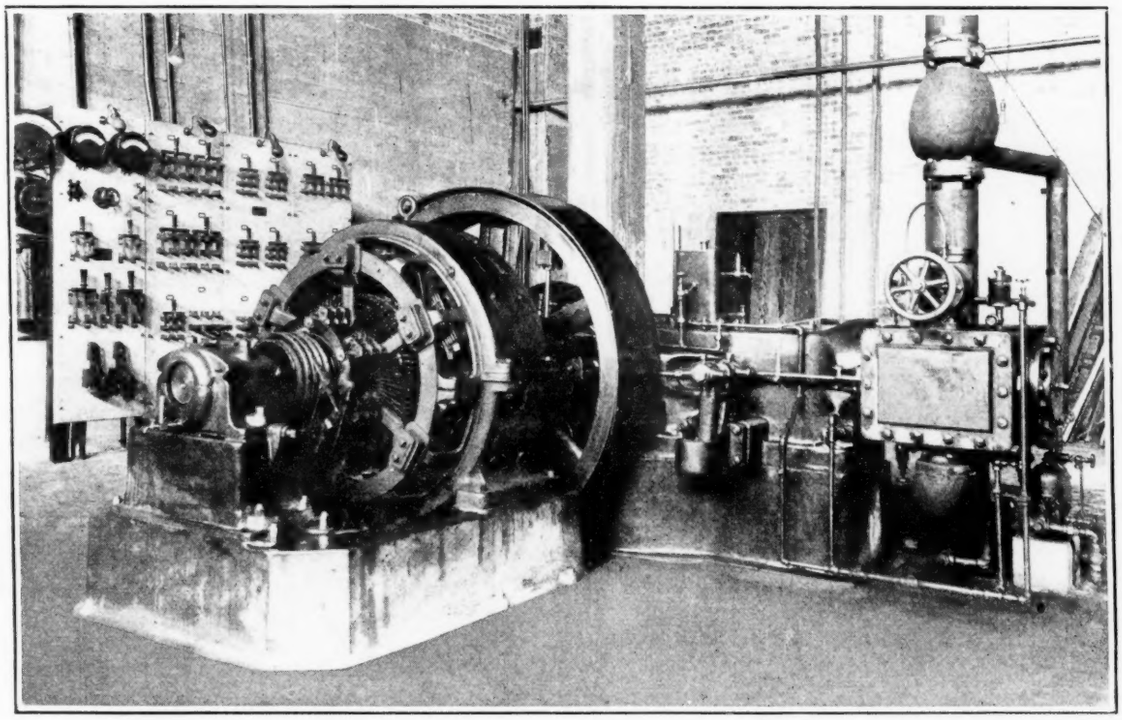
Ques. 7—How may the presence of fatty acids be detected in lubricating oils?

Ques. 8—How many handholes should there be in a vertical fire-tube boiler?

Ques. 9—For best results, what changes should be made in a single direct-acting steam pump to convert it into an air compressor?

Ques. 10—In operation of a link-motion reversing valve gear, what is meant by the slip of the link?

GALVANIZED IRON PIPE should never be used for connecting a CO_2 machine, that draws a continuous sample to the sampling point at the boiler. The sulphur dioxide in the flue gas attacks the zinc coating on the pipe, forming zinc sulphate. This soon plugs the pipe and prevents the flue-gas sample from being drawn through it.



How To Operate D.-C. Generators at
Voltages and Speeds Other Than Given on the Nameplate*

By C. B. HATHAWAY

Motor Engineering, Westinghouse Electric & Manufacturing Company

ALMOST any shunt or compound motor can be operated as a generator and develop its rated voltage if it is driven about 35 per cent faster than its rated speed. A rheostat should be inserted in the shunt-field circuit in order to control the voltage. The armature should be rotated in the same direction as it runs as a motor. If the opposite direction of rotation is required either the armature or shunt-field leads must be reversed, before the machine will generate. If the original direction of rotation is retained the series-field leads must be reversed.

The current output should not exceed the value stamped on the nameplate in order to avoid overheating of the armature. The voltage across the shunt-field leads should not be greater than the rated voltage as a motor for the same reason.

Sometimes a motor is encountered which does not have the magnetic density high enough in the iron circuit to make it operate stably as a generator. A symptom of such a condition is that the voltage falls rapidly with increase of current. The voltage may fall to zero before full load is put on the machine, or it may vary under steady load from minor disturbances. The proper way to correct such a condition is to increase the flux density in some part of the machine's magnetic circuit. This can be done by reducing the cross section of the yoke or the main poles.

The foregoing procedure is not always convenient because the amount of reduction of the section can be determined only if the constants of the machine are known, and secondly it involves considerable machine work to cut away this material. As a substitute, the shunt-field winding can be connected in two parallel paths, as in Figs. 1 and 3, and the machine operated at reduced speed. Care should be taken to see that the shunt-field coils do not become excessively hot as they may be overloaded. The field rheostat should have twice the current capacity and 75 per cent more resistance than one controlling a field with all the coils in series.

If it should be found desirable or necessary to run the machine as a generator at the same speed that it is

* A previous article in the August 16th issue on page 240 treated cases of direct-current motors operating under abnormal conditions.

rated as a motor it can be accomplished by connecting the shunt-field coils in two parallel paths as before. With this arrangement the terminal voltage should not be allowed to exceed about 85 per cent of its rated voltage. That is, a 230-volt motor should not be operated at more than 200 volts as a generator when running at its rated speed. The shunt-field winding would have to be worked too hard to obtain a higher terminal voltage and it may be damaged in attempting to do so.

Voltage Range As a Generator

There is a considerable range of voltage through which the ordinary industrial-type motor can be operated as a generator. As pointed out before, the machine will generate rated voltage if operated at 135 per cent of its rated speed. The generated voltage will vary directly with the speed of the machine. For example, a motor rated 230 volts 850 r.p.m. should be run 1,150 r.p.m. in order to deliver 230 volts as a generator. It should be run 1,500 r.p.m. for 300 volts, 2,000 r.p.m. for 400 volts, 875 r.p.m. for 175 volts, 625 r.p.m. for 125 volts and so on. The shunt-field coils should be left in series if the speed is 135 per cent of the rated speed or higher. They should be connected in two parallel circuits if operated between 70 per cent and 135 per cent of the rated speed. Between 35 per cent and 70 per cent of the nominal speed the shunt coils should be connected in four parallel paths.

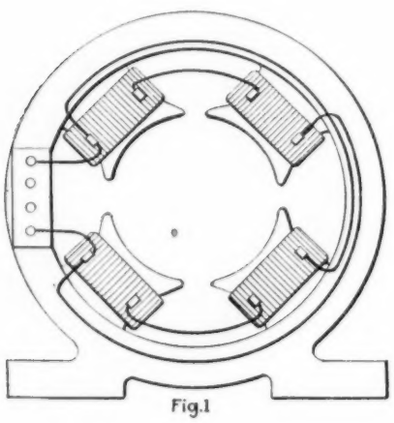


Fig.1

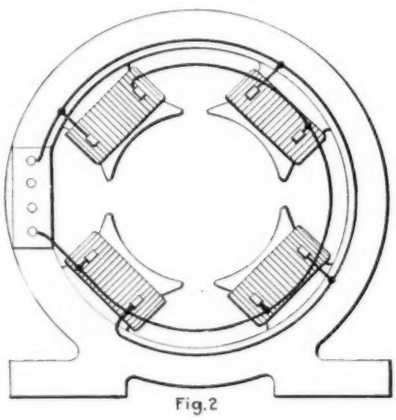


Fig.2

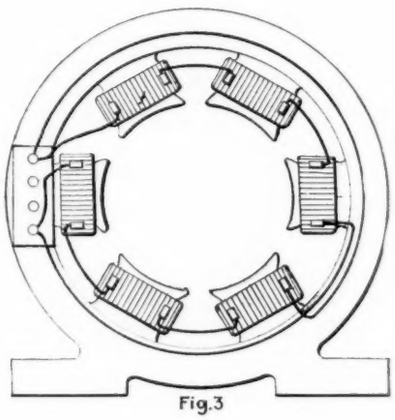


Fig.3

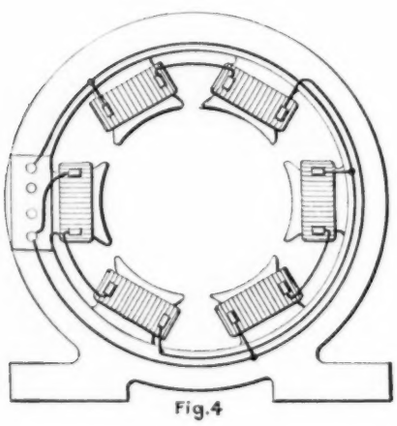


Fig.4

Fig. 1—Four field coils connected in two parallel circuits

Fig. 2—Four field coils connected in four parallel circuits

Fig. 3—Six field coils connected in two parallel circuits

Fig. 4—Six field coils connected in three parallel circuits

Fig. 5—Six field coils connected in six parallel circuits

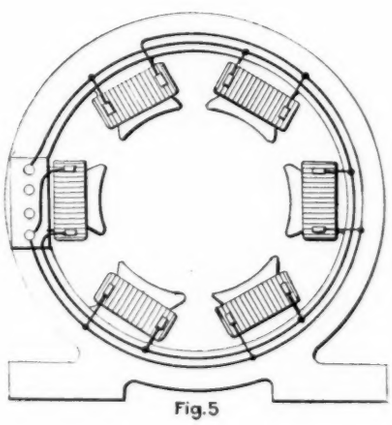


Fig.5

Rheostat Calculation

To control the above generators, the capacity of the rheostat required will depend upon the voltage generated and the connection of the shunt-field coils, that is, whether connected in series or parallel. For normal generator operation at 135 per cent of rated speed and full voltage, the resistance of the rheostat should be equal to that of the shunt-field. The maximum current capacity should not be less than one and one-half times the normal shunt-field current and the minimum should not be less than three-fourths of this normal current. When the machine is to be operated at higher speeds in order to obtain higher voltages, a rheostat with higher resistance must be used. The maximum and minimum current capacities will be the same as before. To obtain the resistance of a rheostat for a higher voltage divide the new voltage by the normal and multiply by the combined field and rheostat resistance for the normal voltage. Then deduct the field resistance from the total resistance thus obtained and the remainder represents the value of the new rheostat resistance.

As an example, consider a 230-volt motor rated at 850 r.p.m. Suppose the shunt-field current is 0.8 ampere at 230 volts. By Ohm's law, the resistance is $230 \div 0.8 = 288$ ohms. Then if 230 volts is required as a generator, the speed should be increased 35 per cent. or increased to $1.35 \times 850 = 1{,}150$ r.p.m. The maximum current capacity of the field rheostat should be $0.8 \times 1.5 = 1.2$ amperes and the minimum capacity $0.8 \times 0.75 = 0.6$ ampere. Making the resistance of the rheostat equal to that of the field coils, it will have 288 ohms. This amount when all cut in, will be sufficient to kill the terminal voltage of the generator. Normally only part of the rheostat will be used. Next, suppose a voltage of 350 is wanted, the speed should then be $\frac{350}{230} \times 1{,}150 = 1{,}750$ r.p.m. The combined rheostat and

field resistance $= \frac{350}{230} \times (288 + 288) = 880$ ohms. Deducting the field resistance from this figure leaves 880 — 288 = 592, or approximately 600 ohms, which is the required resistance for the new rheostat. The maximum and minimum current capacity should be 1.2 and 0.6 amperes as before.

As stated previously, the shunt coils must be connected in two parallel circuits if the speed is between 70 per cent and 135 per cent of the normal speed. In figuring the rheostat capacity, the speed taken as 70 per cent of the rated speed should be considered the basis for calculating the rheostat for any speed between the limits of 70 per cent and 135 per cent of the rated speed. The method used is exactly the same as previously outlined. This can best be demonstrated by a concrete example. Taking the same machine as in the preceding example, the speed will be $0.70 \times 850 = 595$, or say 600 r.p.m. The voltage will be $\frac{600}{1,150} \times 230 = 120$ volts. Since the field circuit is to be connected, in two parallel paths, the resistance is now one-fourth of that which it was when all coils were in series, or $288 \div 4 = 72$ ohms. Therefore, the rheostat should have about 72 ohms resistance with double the current capacity of the rheostat first considered, or a maximum of 2.4 and a minimum of 1.2 amperes.

Now, suppose a voltage of 175 is desired. The speed should be $\frac{175}{230} \times 1,150 = 875$ r.p.m. (Bear in mind that 1,150 r.p.m. or 135 per cent of the rated speed is the basic speed for all voltage calculations when the motor is operated as a generator.) The combined resistance of the rheostat plus the field should be $\frac{175}{120} \times (72 + 72) =$ 210 ohms. The rheostat, therefore, should have 210 — 72 = 138 or approximately 140 ohms. The current capacity would still be 2.4 amperes maximum and 1.2 amperes minimum.

The shunt-field coils of a 4-pole motor must all be connected in parallel, as in Fig. 2, if the speed as a generator is less than 70 per cent of the rated motor speed. However, the basis for calculating the rheostat is now 35 per cent of the rated speed. The resistance of the field will be one-sixteenth of that value measured when they were all in series. The current capacity of the rheostat will be 4 times the original all-in-series value. A 4-pole motor will not operate as a self-excited generator below 35 per cent of its rated speed.

A six-pole motor can be operated as a generator between 45 per cent and 70 per cent of the rated motor speed with the fields in 3 parallel circuits, as in Fig. 4, and from 22 per cent to 45 per cent of the rated speed if all shunt coils are in parallel, as in Fig. 5.

CHANGED OPERATING CONDITIONS FOR DIRECT CURRENT GENERATORS AND THE RESULTS

Conditions	125-V. Generators, shunt or compound 5 kw., 900 r.p.m. 7½ kw., 1,150 r.p.m. 10 kw., 1,750 r.p.m.	250-V. Generators, shunt or compound 5 kw., 900 r.p.m. 7½ kw., 1,150 r.p.m. 10 kw., 1,750 r.p.m.	550-V. Generators, shunt or compound 5 kw., 900 r.p.m. 7½ kw., 1,150 r.p.m. 10 kw., 1,750 r.p.m.	125-V. Generators, shunt or compound 25 kw., 900 r.p.m. 40 kw., 1,150 r.p.m. 50 kw., 1,750 r.p.m.	250-V. Generators, shunt or compound 25 kw., 900 r.p.m. 40 kw., 1,150 r.p.m. 50 kw., 1,750 r.p.m.	550-V. Generators, shunt or compound 25 kw., 900 r.p.m. 35 kw., 1,150 r.p.m. 50 kw., 1,750 r.p.m.
Normal operation as a generator.	75-ohm rheostat, 2.5 amp. max. and 1.25 amp. min. capacity.	200-ohm rheostat, 1 amp. max. 0.5 amp. min. capacity.	1,250-ohm rheostat, 0.5 amp. max. 0.25 amp. min. capacity.	50-ohm rheostat, 3 amp. max. 1.5 amp. min. capacity.	125-ohm rheostat 2.5 amp. max. 1.25 amp. min. capacity.	800-ohm rheostat, 1.5 amp. max. 0.75 amp. min. capacity.
To operate at double voltage. Run at double speed. This does not anply to 1,750 r.p.m. generator.	250-ohm rheostat, 2.5 amp. max. 1.25 amp. min. capacity.	800-ohm rheostat, 1 amp. max. 0.5 amp. min. capacity.	Not applicable.	200-ohm rheostat, 3 amp. max. 1.5 amp. min. capacity.	450-ohm rheostat, 2.5 amp. max. 1.25 amp. min. capacity.	Not applicable.
To operate at highest attainable voltage. Run at 2,250 r.p.m.*	300-ohm rheostat, 2.5 amp. max. 1.25 amp. min. capacity. 900 r.p.m. gen. good for 300 v. 1,150 r.p.m. gen. good for 250 v.	950-ohm rheostat, 1 amp. max. 0.5 amp. min. capacity. 900 r.p.m. gen. good for 600 v. 1,150 r.p.m. gen. good for 500 v.	Not applicable.	220-ohm rheostat, 3 amp. max. 1.5 amp. min. capacity. 900 r.p.m. gen. good for 300 v. 1,150 r.p.m. gen. good for 250 v.	550-ohm rheostat, 2.5 amp. max. 1.25 amp. min. capacity. 900 r.p.m. gen. good for 600 v. 1,150 r.p.m. gen. good for 500 v.	Not applicable.
To operate at half voltage. Run at half speed. Connect shunt coils in 2 parallel paths.	30-ohm rheostat, 5.0 amp. max. 2.5 amp. min. capacity.	100-ohm rheostat, 2.5 amp. max. 1.25 amp. min. capacity.	300-ohm rheostat, 1.2 amp. max. 0.6 amp. min. capacity.	30-ohm rheostat, 6.0 amp. max. 3 amp. min. capacity.	65-ohm rheostat, 5.0 amp. max. 2.5 amp. min. capacity.	200-ohm rheostat, 3.0 amp. max. 1.5 amp. min. capacity.
To operate at lowest attainable voltage. Connect shunt field coils in 4 parallel paths. Run 900 r.p.m. gen. at 250 r.p.m. Run 1,150 r.p.m. gen. 350 r.p.m. Run 1,750 r.p.m. gen. 525 r.p.m.	Good for 30 v. 7-ohm rheostat, 10 amp. max. 5 amp. min. capacity.	Good for 60 v. 20-ohm rheostat, 5 amp. max. 2.5 amps. min. capacity.	Good for 140 v. 80-ohm rheostat, 2.5 amp. max. 1.25 amp. min. capacity.	Good for 30 v. 5-ohm rheostat, 12 amp. max. 6 amp. min. capacity.	Good for 60 v. 10-ohm rheostat, 10 amp. max. 5 amp. min. capacity	Good for 140 v. 65 ohm rheostat, 5. amp. max. 2.8 amp min. capacity.
To operate as motor at rated voltage. Shunt generator may not run steadily. 900 r.p.m. gen. will run 775. 1,150 r.p.m. gen. will run 1,000. 1,750 r.p.m. gen. will run 1,500.	Use 20-ohm resistor, 1.7 amp. cap'y in shunt field circuit. 5-kw. gen. good for 5.5 hp. 7½-kw. gen. good for 8.5 hp. 10-kw. gen. good for 11.5 hp.	75-ohm resistor in shunt field 0.8 amp. 5 kw. gen. good for 5.5 hp. 7½-kw. gen. good for 8.5 hp. 10-kw. gen. good for 11.5 hp.	350-ohm resistor in shunt field, 0.4 amp. 5 kw. gen. good for 5.5 hp. 7½-kw. gen. good for 8.5 hp. 10-kw. gen. good for 11.5 hp.	Use 15-ohm resistor 3 amp. cap'y. in shunt field, 25-kw. gen. good for 27.5 hp. 40-kw. gen. good for 45 hp. 50-kw. gen. good for 55 hp.	Use 35-ohm resistor 1.75 amp. cap'y in shunt field. 25-kw. gen. good for 27.5 hp. 40-kw. gen. good for 45 hp. 50-kw. gen. good for 55 hp.	Use 200-ohm resistor 1.0 amp. cap'y. in shunt field. 25-kw. gen. good for 27.5 hp. 40-kw. gen. good for 45 hp. 50 -kw. gen. good for 55 hp.
To operate as motor at rated speed or higher. Shunt machine may not run steadily.	200-ohm rheostat, 1.7 amp. max. 0.5 amp. min. capacity.	650 - ohm rheostat 0.85 amp. max. 0.3 amp. min. capacity.	1,000-ohm rheostat, 0.4 amp. max. 0.3 amp. min. capacity.	135 - ohm rheostat, 2.75 amp. max. 0.8 amp. min. capacity.	375 - ohm rheostat, 1.75 amp. max. 0.5 amp. min. capacity.	450 - ohm rheostat, 0.9 amp. max. 0.65 amp. min. capacity.
To operate as motor at half voltage and full speed. Shunt machine may not run steadily.	25-ohm rheostat, 1.5 amp. max. 0.75 amp. min. capacity.	85-ohm rheostat, 0.7 amp. max. 0.35 amp. min. capacity.	350-ohm rheostat, 0.3 amp. max. 0.15 amp. min. capacity.	12-ohm rhesotat, 2 amp. max. 1 amp. min. capacity.	35-ohm rheostat, 1.5 amp. max. 0.75 amp. min. capacity.	100-ohm rheostat, 1 amp. max. 0.5 amp min. capacity.

*Do not run any machine above 2,250 r.p.m. unless made special for high speeds.

Changing a Generator's Speed

Inasmuch as there is no essential difference between a direct-current motor and a generator, the same general laws apply to both. In the case of the generator, the rated speed of the machine is manifestly the basic speed for all voltage calculations. That is, the speed must be doubled if double voltage is required or must be operated at half speed to obtain half voltage. For example, a 250-volt 1,150 r.p.m. generator will develop 125 volts

at 575 r.p.m., 200 volts at 920 r.p.m., 300 volts at 1,380 r.p.m., 350 volts at 1,610 r.p.m., etc. The shunt-field coils should be left in series when operated at rated speed or faster. Between half and rated speed, the coils should be connected in two parallel paths. The calculation of the rheostat should be based on half voltage. Between one-quarter and one-half speed, the shunt-field coils should all be in parallel if the machine has four poles. Again the rheostat calculations are based on the lowest voltage. A four-pole generator cannot be operated self-excited below one-fourth the rated speed or voltage.

A six-pole generator should have its shunt coils arranged in three paths for voltages between one-third and one-half the rating. Between one-third and one-sixth voltage they should all be in parallel. The rheostat calculations can be carried out in exactly the same way as discussed for a six-pole motor driven as a generator.

Generator Without Series Winding

Sometimes it is desired to operate an ordinary compound-wound generator as a shunt-wound machine. In many cases, such a machine will carry at least part of the load given on the name-plate, but will not carry full load at full voltage. The reason for this is that the shunt coils in a compound-wound generator are normally designed for less ampere-turns at the same applied voltage than are the coils in a shunt-wound machine. Consequently, even with the rheostat all cut out, the shunt-field ampere-turns are insufficient without the aid of the series winding to maintain the terminal voltage at full load.

This condition can be remedied by increasing the speed of the armature or, if this is impracticable, the shunt-field coils can be arranged in two parallel paths. If the latter is resorted to, caution must be taken to avoid overheating of the field coils because they may be overloaded. Furthermore, a much larger rheostat must be used with the coils in two paths instead of in series. For this service the current capacity of the field rheostat must be double and its resistance made 75 per cent greater than that used before the field coils were paralleled.

Voltage with Constant Speed

All generators have a limited range of voltage, with a given field arrangement, over which they can be controlled by the field rheostat. The high voltage is limited by the saturation of the magnetic circuit together with the characteristic of the shunt field. The low voltage is limited by the characteristic of the flux path and by the fact that it is self-excited. The range can be increased by separately exciting the machine. If the magnetic circuit is saturated at the high voltage when self-excited, little improvement can be made. The low voltage can be brought down as low as the residual magnetism will permit.

A generator that is operated at a speed too high for a given voltage may be unstable and its voltage fail at ordinary loads. If possible, the speed should be decreased about 20 per cent, which will permit the amount of saturation of the magnetic circuit necessary in all self-excited machines. If the speed cannot be conveniently reduced, the machine can be operated at a higher voltage, and the shunt coils paralleled if necessary.

Operating a Generator as a Motor

Although there are cases where generators have been operated as motors with rated voltage on the shunt-field coils, it will be found that the shunt-field current should not be allowed to exceed the normal value in certain types of machines. It may be necessary to insert a resistor in series with the shunt winding if the line voltage exceeds 80 per cent of the machine's rated voltage. If the machine operates on a line whose voltage is equal to its own rated voltage, and if the shunt-field current is held the same as when operating as a generator, the speed will be about 80 per cent of its rating as a generator.

A shunt generator, having no series-field winding, may not run steadily as a motor. That is, it may hunt when load is applied. This instability will be more pronounced if the machine is operated at high speeds, obtained by weakening the shunt field. A few turns of cable wrapped around each main pole and connected in the armature circuit should be sufficient to stabilize the speed. Shifting the brushes in the direction of rotation will produce a compounding effect which may be sufficient to stabilize the machine without the addition of the series turns on the poles. This procedure is not recommended unless the commutation is exceptionally good with the brushes on neutral and where there is but very little sparking with the brushes shifted. As a general policy, it is recommended that shifting of the brushes should be done only if a small change in the brush position will overcome the difficulty. If they must be shifted so far that the commutation becomes questionable, it should be considered only as a temporary measure.

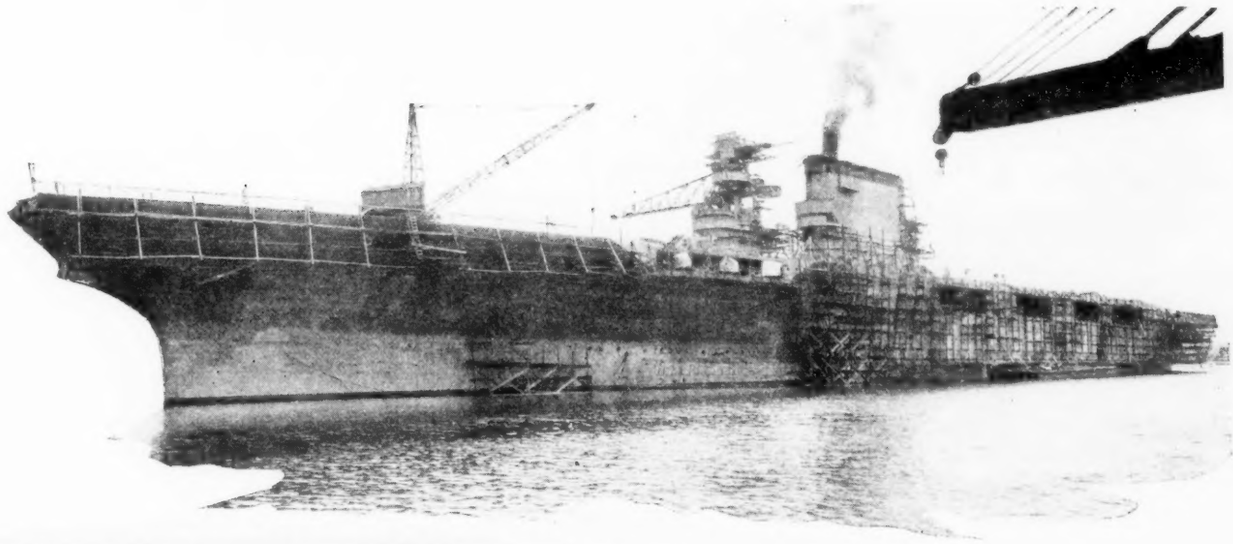
A compound-wound generator usually has more series turns in the field than does a compound-wound motor of the same dimensions. Consequently, it may prove desirable to shunt a part of the current from this field when operating as a motor; otherwise the speed regulation will be very poor. The series winding should always be shunted if the speed is to be controlled by weakening the shunt field. With full series ampere-turns and a weak shunt field, the speed characteristic with different loads will approach that of a series-wound motor and may have a dangerously high speed at light loads. The series field must be reversed with respect to the armature when operating a generator as a motor in the same direction of rotation.

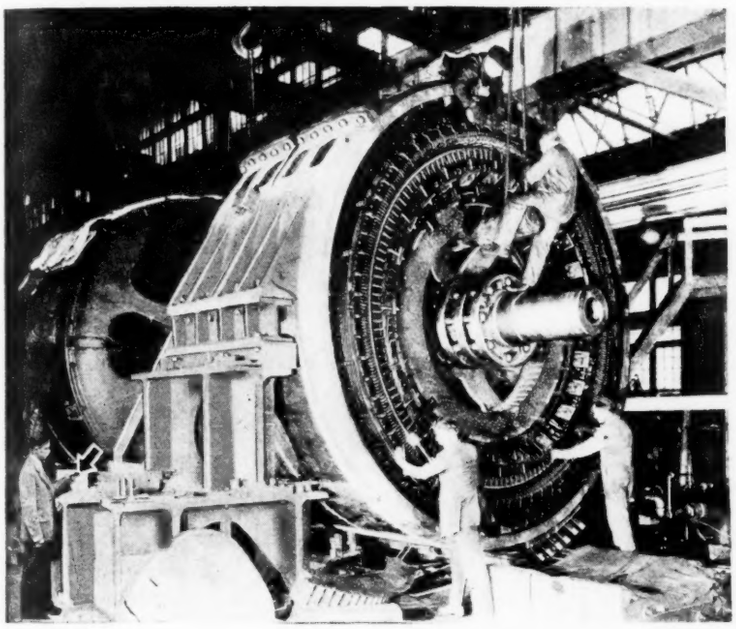
The application of a series-wound generator is found so rarely that it has been omitted from this discussion.

Use of the Charts

The accompanying charts are given only to serve as guides in calculating the rheostats and connections required for different needs. The figures given are only approximate, but probably are close enough to obtain fairly accurate results with most modern machines. The figures may not be satisfactory for use with old types of machines which have very heavy shunt fields. The individual machines should be checked in any case if accurate results are required. The shunt field resistance can be measured readily with a voltmenter and an ammeter by applying Ohm's law.

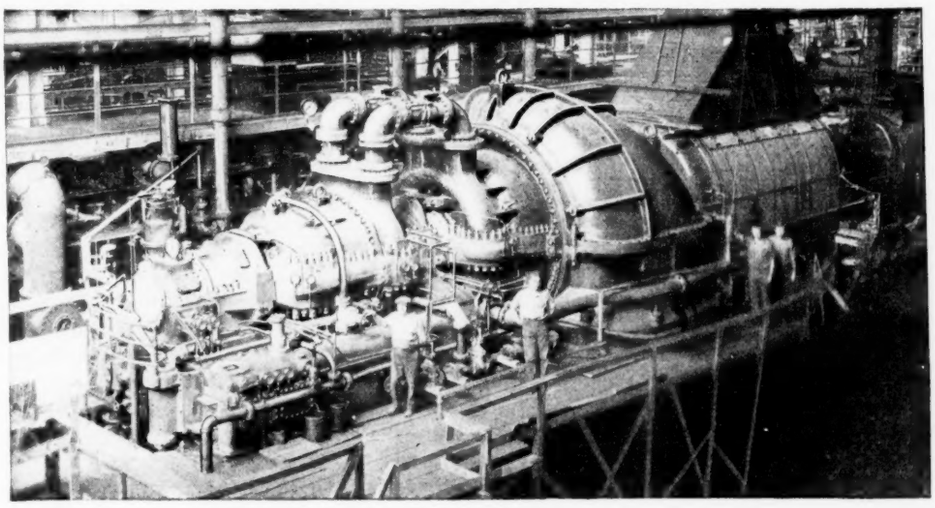
As an example of the use of the chart, assume that it is desired to operate a 25-kw. 250-volt 900 r.p.m. generator to obtain double voltage, or 500 volts. In the first column on the left under "Conditions" in the second item from the top it is stated, "To operate at double voltage, run at double speed." This would make the new speed $900 \times 2 = 1{,}800$ r.p.m. In the column headed "250-V. Generator," second item from the top, the requirements of the new rheostat are given as 450 ohms, 2.5 amperes maximum and 1.25 amperes minimum capacity. This gives the requirements for operating the machine at double voltage.





The airplane carrier "Lexington" (above) now nearing completion at the Fore River Shipbuilding Yard in Quincy, Mass., and her sister ship, the "Saratoga," will be the largest and the highest-powered naval vessels afloat. The propelling machinery of the "Lexington" comprises four 35,200-kw. turbine-generators supplying eight 22,500-hp. motors, two to each shaft. One of these is shown at the left. Sixteen oil-fired boilers will furnish steam to the turbines. This power plant will be capable of driving the ship at a speed of 33 knots

At the right is one of the two largest turbine-generators built in this country for export. It is shown on the test floor of the General Electric Co. preparatory to shipment to Buenos Aires for the new station of the Compania Hispano-Americana. Each of these units is a tandem compound of 52,500 kw. capacity employing reheat and operating on 550-lb. 750-deg. steam



Fuel Systems of the High-Speed Diesel Engine

Discussion of Present Practices in Fuel Pumps—Outline of High-Speed Requirements—Advantages of Various Systems

By W. Marx Kaufmann

THE exacting requisites of the high-speed Diesel engine with regard to flexibility of operation and accurate quick responsive control have required the highest grade of fuel-pump mechanisms and fuel systems. Other considerations have occupied the minds of engine designers, such as reduction of weight in the reciprocating masses and lubrication, but none of these has claimed more far-reaching attention and research than the fuel system.

The chief characteristic which seems to be common to all fuel systems of high-speed oil engines is that the fuel pumps can be so adjusted as to deliver a metered amount of fuel per power stroke of each cycle, the displaced volume of oil to be regulated by governor control in accordance with the load. The manner in which this regulation is accomplished is radically different for the various types, making a study of the methods employed an interesting one. All are similar, however, in that they contain three fundamental elements: A control box, which incloses the fuel-pump camshaft, cam rollers, levers, governing device or open control gear; a fuel pump, which forces a measured quantity of oil into the high-pressure fuel line, and a spray plug or nozzle which functions as an atomizer of the delivered charge of oil. The variations in design of these elements will be discussed in this article.

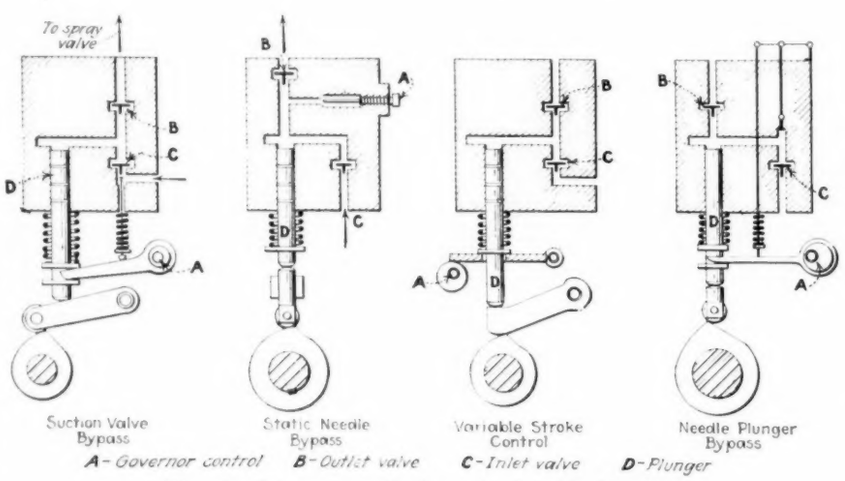


Fig. 1—Diagrammatic layout of typical pumps

The primary features noted in control-box design are accessibility and correct functioning of the cam mechanism in co-operation with governor control linkages. Since one of the important essentials of the high-speed Diesel engine is the ability to operate over a wide range of speeds, especially if portable service is considered, it becomes necessary to provide for changes in the timing of injection to prevent afterburning. The fuel-pump camshafts are therefore constructed to allow for adjustment of the individual cams or of the complete shaft. In the former type the fuel-pump cams are of large diameter, having four elliptical slots equally spaced circumferentially around their faces. The shaft is provided with a series of keyed flanges, one per pump, being tapped to receive four studs at radial distances coinciding with the cam slots. The camshaft, when assembled, consists of the cams clamped rigidly to these flanges. To advance or retard injection, it is but necessary to loosen the nuts, move the cam in line with the slots a few degrees and tighten into position. A vernier refinement in the form of an adjustable eccentric cam lever provides complete control of timing.

Where the cams are cast or forged integral with the shaft or keyed thereto, splines are provided at one end to engage with corresponding broached grooves in the cam gear. The entire shaft may be turned the desired number of degrees and locked into place. If straight splines are used, they necessitate only the removal of the camshaft sufficiently to clear the gear grooves to turn the shaft in the proper direction. The inherent simplicity of this patented construction is evident.

As practically all high-speed Diesels operate on the constant-stroke fuel pump principle, a bypass or cutoff governor control is incorporated in the fuel pump body, the mechanisms of which are actuated by the motion of the governor lever. These mechanisms are placed either within or directly on top of the control box and consist essentially of a device that will convert the relatively long oscillatory motion of the end of the governor arm into a short straight-line accurate movement. In one instance, shown in Fig. 1, an eccentric shaft raising or lowering a fork, the prongs of which ride on the pump plunger, serve as a means for opening a spring-loaded bypass valve. Another system involves the use of a timing coupling which is fastened rigidly to the camshaft by the use of helical splines. Adjustments are obtained

by moving the coupling in line with the shaft. A more complex type involves the use of a modified epicyclic transmission. A recent patented system consists of a wedge control which, by raising or lowering the bypass lever, gives almost instantaneous response and acceleration to the engine.

The element that is the greatest variable in fuel-systems research is the fuel pump. Study along the lines of effect of plunger diameter, stroke and valve action is at present revealing new facts which will aid in promoting more accurate and efficient design of this part of the high-speed Diesel engine.

The constant-stroke pump consists of a pump plunger, suction valve, outlet valve and bypass valve. The first three parts have a distinct similarity in all types. The plunger is of steel and generally lapped into a close-grained cast-iron bushing which in turn is tightly clamped into the fuel pump body. The valves have conically ground seats and are made light enough in weight, so that about 10 to 20 lb. pressure on the fuel will lift them from their seats. It is in the bypass valve that a good deal of independent design and ingenuity presents itself. A successful type used in pumps operating up to 4,000 lb. per sq.in. pressure, is the needle-pointed plunger valve. The stem is loaded with a light spring and operated through a linkage with the governing mechanism, assuring positive seating of the valve at full load. At a point determined by the governor, the control mechanism lifts

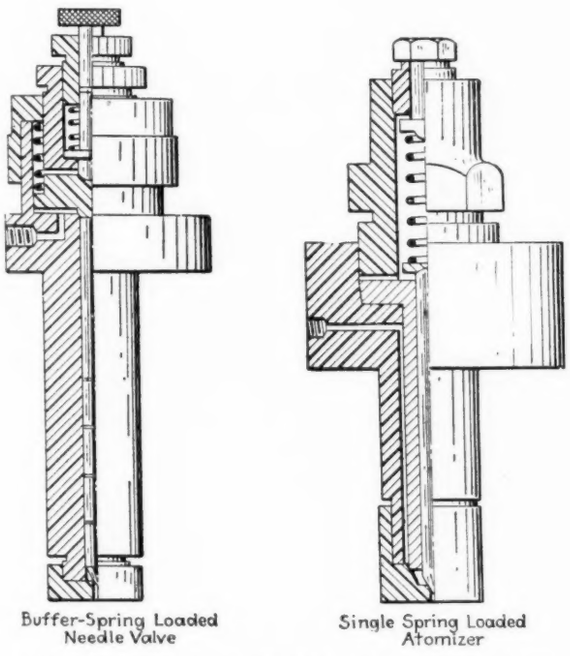


Fig. 2—Single- and double-spring spray valves

the valve off its seat when operating at low loads, and the fuel is bypassed into the suction line.

An unusual method of control, shown in Fig. 1, consists primarily in the manipulation of a static bypass needle valve. The valve stem is threaded into a heavy plug, and its motion corresponds to the number of turns through which the threads move, this being determined by a control arm extended from the governor bellcrank. The application of the bypass plug valve is frequent and has been used with material success against pressures up to 8,000 lb. per sq.in. In this type the valve opens directly into the pressure stream and closes on a conical seat at the end of its stroke. Several high-speed engines dispense with the separate bypass and incorporate it directly in the suction line in the form of a suction-valve regulator.

The injection valve is the final destination of the oil charge before entering the cylinder, the fuel being transmitted through the injection-valve tube, which in itself, is of no little importance in securing proper atomization effect. The essential requirement of the valve is the

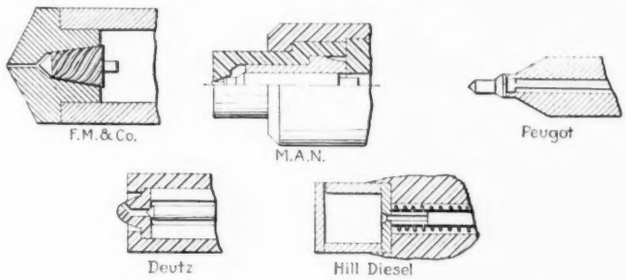


Fig. 3—A number of spray nozzles used on high-speed engines

ability to open with a quick start and close with sharp precision. Dribbling, through the lack of these requisites, will result in inefficiency due to late burning. The type resorted to in almost all high-speed Diesel engines consists of a spring-loaded steel needle valve lapped into a cast-iron bushing and incased in a forged or cast-steel housing. This is bolted directly onto the cylinder head by means of a thick flange and large studs. The spray plug, Fig. 2, receives its charge through a small steel tubing, the pressure of the oil balancing and finally overcoming the spring pressure in a small fraction of a second, thus forcing the valve off its seat and allowing the fuel to rush into the cylinder chamber. Surging of the valve has been a frequent trouble with this type in high-speed work, but has been eliminated with some success by the use of two springs, as shown at the right in Fig. 2—one heavy adjustable spring, and the other of smaller wire dimensions to act as a "buffer," permitting added length of opening under increased spring pressure. Other methods are the helical grooved nozzles plug, the simple single-hole plug, and the fuel-metering device practice. Precombustion chambers are popular, in that they eliminate many required refinements of direct injection. Several different spray devices are shown in Fig. 3.

The ultimate step in the fuel system is the passage of fuel from the spray nozzle into the combustion chamber. More defects in combustion have been traced to this part of the system than to any of the elements described. Proper atomization of the oil into a mist of minute globules that can be readily vaporized by the heated air and swiftly burned, is imperative. Correct design of the nozzle orifices can be secured only by experimentation, as this will vary considerably for each make of engine, combustion chamber, or displacement and clearance volumes. The shape of the spray, which is determined by the angle between the orifices or size of single orifice, will depend for its pattern upon the shape of the cylinder clearance space. The average figures divulged by various manufacturers hint at a recommended practice of values ranging from 0.008 in. to 0.012 in. diameter orifices.

Research in this field is still quite lively, and more will be understood in the future regarding the nature of atomization effects, with the increased number of interested and unselfish investigators entering this work.

Some Notes on Steam Turbine Development

II. Development of the Proper Design of Turbine Casings

By W. J. A. London

MR. LONDON, in the second article of his series, traces the various steps in the evolution of the design of turbine casings. In addition, he brings out some interesting points regarding the "passing out" of the vertical type turbine.

REFERENCE has been made, in the previous article of the series, to the importance of the correct design of the so-called *stationary* elements of the turbine. The casing itself calls for first consideration, the one principal requirement being that, throughout all temperature changes, it will retain as nearly as possible the calculated clearances to prevent fouling.

Requirements of Casing Design

The following are some of the major requirements which must be given consideration in the design of a turbine casing:

1. The design must allow for free expansion in all directions. This expansion must be uniform; that is, no material deviation from the original formation being permitted. This requires that special attention be given to the location and design of the feet, or supports, so as not to interfere with the expansion requirements mentioned.

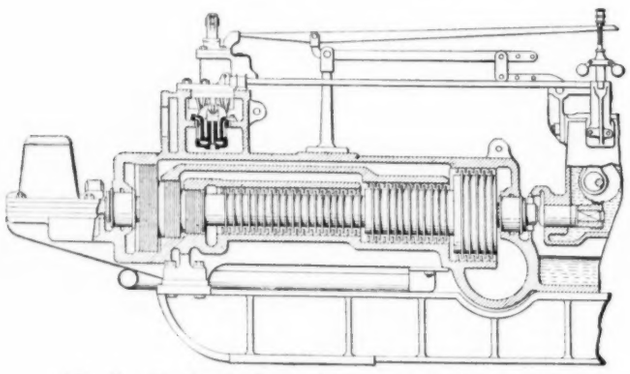


Fig. 1—Early design of Parsons turbine casing

2. The design of the high-pressure end to withstand safely the steam pressures employed is not one of great difficulty, although the expansion effect of flanges and ribs subjected to high temperatures must be carefully considered.

3. The external stress to which the casing is subjected introduces one of the most difficult problems involved. The steam-pipe end can be conveniently taken care of by the introduction of a flexible pipe between the steam chest and the casing proper, but the exhaust end presents a more serious proposition. This can be best understood when we consider that an exhaust pipe 11 ft. in diameter (or its equivalent area), subjected to a vacuum of 29 in., exerts an unbalanced pull of approximately 100 tons.

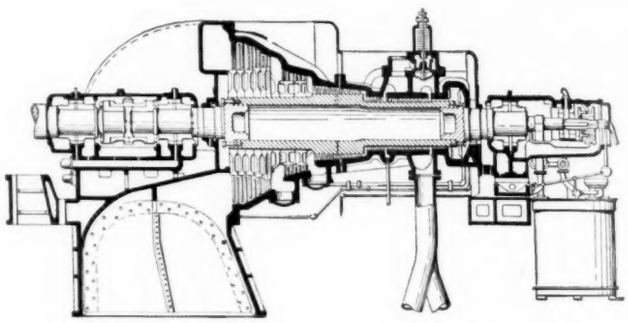


Fig. 2—Modern design of reaction turbine casing

Vertical-Type Turbines

With the foregoing essentials before us, the old vertical type of turbine was ideally suited to meet the requirements. The pull of the exhaust pipe was uniformly distributed, substantially uniform expansion could be expected, and with the elimination of the sagging of the shaft alignment problems became easier.

While many of these vertical machines are still operating satisfactorily, there are obvious reasons why this design had to be abandoned, in spite of all the advantages cited.

Apart from the design of the machine itself, the advantages claimed by the saving of floor space and cost of foundations were in a great measure exaggerated or actually non-existent, as evidenced by the way the main units are spread out in the average station to make room for the attendant auxiliaries.

At the time when feeling was running high between the two principal groups of turbine manufacturers as to the relative merits of the vertical and horizontal types,

an amusing discussion took place at one of the engineering society meetings. An advocate of the vertical machine had read a paper and expounded at length on the merits of this type, pointing out the advantages to be gained in floor space by placing the condenser in the

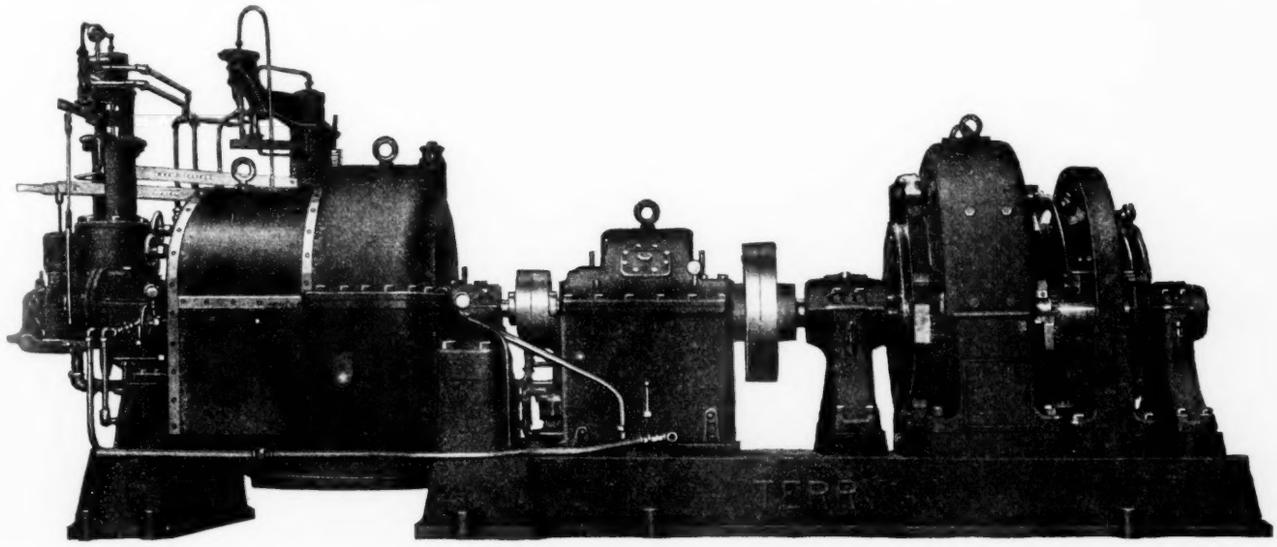


Fig. 3—Terry turbine

base plate of the machine, the turbine directly above that and, lastly, the generator and governor on top.

The representative of one of the horizontal turbine builders arose during the discussion and frankly stated that the advantages pointed out by the original speaker were self-evident, and expressed appreciation of the ingenuity of the design. He pointed out, however, that he did not feel that the designers of this machine had availed themselves of the full opportunity presented by such a construction. He suggested the following improvement: That the boilers be placed in the basement, the condenser directly above, then, in order, the turbine, the generator, etc. Then, by the employment of a hollow shaft, this might be used as the smokestack.

The inaccessibility of the vertical design naturally led the manufacturers to discontinue the building of this type, accepting as good-naturedly as possible the manifold advantages of the horizontally split machine. The old arguments that periodic inspection was unnecessary had been exploded, and as machines grew larger the time the machine was off the line had to be capitalized.

Comparison of Early-day and Modern Casing

A further consideration of the reaction turbine shows how essential it is that a true cylindrical formation of the casing be maintained under all pressure and temperature conditions.

In a comparison between the design shown in Fig. 1 of an early Parsons construction, with the modern design, Fig. 2, there is little in common as far as casing design is concerned. The change has not taken place in one step, the progress of this development, like everything else, being evolutionary. Changes were made from time to time, according to the dictates of experience.

In the early design shown in Fig. 1, all sorts of cores were introduced, passages for equalizing pipes, oil-cooling chambers, etc., being cast in the casing itself. As sizes and working temperatures increased, the deformation of the casing increased in like proportion. This necessitated the elimination, as far as possible, of all cast-in passages, and the substitution of flexible external pipes in their place.

One idea, forming the basis of many designs, was that better symmetry of expansion could be obtained by making the cross-section of the material constant throughout (the same weight of metal per inch run) irrespective of the diameter.

The influence of the design and location of the feet or supporting members of the casing with respect to the expansion problem, became an important factor, and innumerable schemes have been employed to give adequate support without interfering with free expansion in the casing itself. The general tendency is either to hang the casing from both ends or to provide semi-flexible supports on the center line. Figs. 3 and 4 show some typical designs in modern practice.

With the introduction of the impulse element in lieu of the long high-pressure cylinder of necessarily small

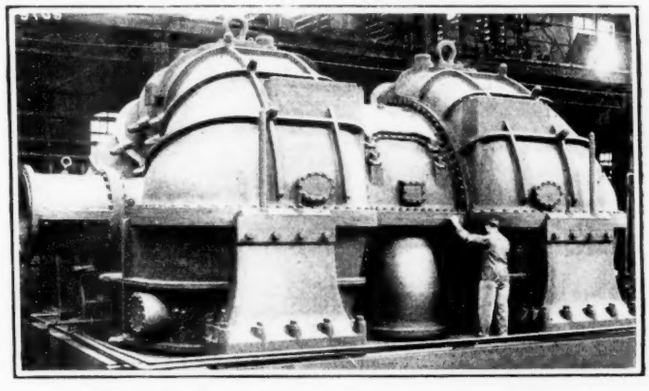


Fig. 4—Westinghouse low-pressure turbine

diameter, not only was the casing shortened, but the whole structure stiffened when it is considered as a beam.

Casings on Marine-Type Turbines

In large marine-type turbines where the reaction principle is employed throughout, long cylinders, because of the low speeds, are essential. Consequently, some inter-

esting problems presented themselves in the design of such turbines as those installed on the "Lusitania" and "Mauretania." With the long span between the bearings and the heavy weight of the casing itself, it was considered that some form of central support would be necessary. The builders of the "Lusitania" (John Brown & Co.) adopted the clever scheme of providing sliding feet at 45 deg., thereby permitting free radial expansion, at the same time carrying the dead weight of part of the casing itself.

Considering the casing as a beam, deep ribs could be used to stiffen the structure and were, in fact, used ex-

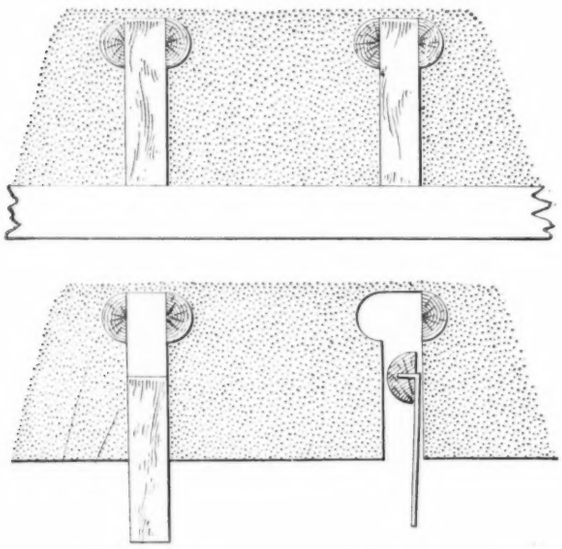


Fig. 5 Method of arranging beaded ribs on pattern so as to facilitate removal from mold

tensively in the smaller machines. For obvious reasons, where varying temperatures are concerned, ribs are undesirable. Where ribbing becomes absolutely necessary, they are made as shallow as possible, the number around the circumference being increased according to the requirements.

Referring again to the turbines on the first Cunarders, the diameter of the casings, being out of all proportion to anything that had been constructed for land work, called for a special study as to the design that would best retain true concentricity. Over thirty full-sized sections were made from varying designs and tested for deformation under operating temperatures. The result was the adoption of beaded ribbing all over the outside of the casings. An interesting precaution was taken in the molding of the castings. Loose cores would be likely to shift, which would materially affect the uniform section of material required, so the beaded ribs were ingeniously designed, as shown in Fig. 5, so that they could be made loose on the pattern and the ribs and beading could be conveniently picked out of the mold.

Announcement Has Been Made of the Award of the John Scott medal for this year to D. D. Knowles, of the Westinghouse Electric & Manufacturing Co., for the invention of the grid glow relay tube. This relay is an extremely sensitive current-controlling device and can be operated by a power of one-billionth watt. The award is made annually in recognition of "inventions for the use and benefit of mankind."

Answers to What Do You Know?

The questions are on page 352

Ans. 1—Prof. Elihu Thomson in 1885, who patented it, and then dedicated the patent to the public.

Ans. 2.—The fuel, upon entering the Diesel cylinder, does not mix with all the air; consequently, there is an explosive mixture even though the charge be but one pound of fuel per 50 pounds of air.

Ans. 3—Not unless the space is filled with cinders, asbestos, etc. An open air space transmits more heat than when the cavity is filled or voided entirely.

Ans. 4—Compression is used to offset the inertia forces of the reciprocating parts, so that the bearings do not pound as the crank passes dead center.

Ans. 5—The weight of dry saturated gas that must be handled by the compressor per minute to produce one ton of refrigeration in 24 hours is

$$W = \frac{200}{H_2 - h_1}$$

where

W = Weight of ammonia handled per minute;
H_2 = Total heat in one pound of ammonia vapor at the coil pressure;
h_1 = Heat of the liquid at the receiver pressure;
200 = B.t.u. removed per minute to equal one ton of refrigeration in 24 hours.

The values of H_2 and h_1 may be found in the tables of the properties of ammonia.

Ans. 6—Oil leaks in piping can be stopped by tinning the threads of the various fittings and then screwing them together at a soldering heat. This is not always possible with iron pipes or large pipes. Using shellac mixed with powdered graphite on such pipes will then secure a tight joint.

Ans. 7—Some engineers use the litmus-paper test to detect the presence of fatty acids. This is not always an indication, since the acids that may exist may not be soluble in water, and solubility is necessary to obtain the reaction on the litmus paper. Or the water used in the test may be so alkaline as to neutralize the acid in the solutions. If a small amount of the oil be placed upon a piece of bright brass, the acid will etch the brass in about thirty-six hours.

Ans. 8—Boilers more than 24 in. in diameter should have not less than seven handholes; namely, three in the shell at or about the line of the furnace crown sheet, one in the shell at or about the water line or opposite the fusible plug when used, and three in the shell at the lower part of the water leg.

Ans. 9—Ordinarily, the water cylinders of pumps are provided with a liberal percentage of clearance volume, as it is advantageous to their operation and adds convenience in their design and construction. For compressing air efficiently, there should be a minimum percentage of cylinder clearance, and conversion of a steam pump into an efficient air compressor would at least require replacement of the water cylinder by a properly designed air cylinder.

Ans. 10—In operation the link and link block vibrate around different centers. Consequently, for each revolution of the crank of the engine the link slips back and forth a certain distance on its block, and this slippage of one on the other is called the slip of the link.

Picking Flaws *in the* Heating System

By W. Edward

IN the previous article a service engineer showed the plant operating men how to make a comprehensive layout of their heating-system pipe lines by means of symbols. This article indicates some of the troubles that were found and explains how they were corrected.

THE service engineer had made his plant inspection and was waiting for us to tell him that our layout was complete. Our part of the work required three days, then we called him.

"So your layouts are finished," he said, when he arrived. "It didn't take as long as you expected."

"No, it was easy after you explained your symbol system."

"All right, we will look it over and I'll spot for you the source of several of your troubles. I saw them during my inspection trip. Then we'll look for more while your pipefitters get started. Now let me see—yes, your return main rises some four or five feet at a point a short distance from the boiler room. Here it is on the plan, Fig. 1. The 6-in. main comes up at a 45-deg. angle out of the long pipe tunnel, travels along the surface in a shallow trench and then drops down to the vacuum pump. That 45-deg. rise is doing more to prevent bringing back the return water than any other thing I have seen. Let me explain.

"A return main is usually only partly full of water that lies at the bottom of the pipe, the rest of the line being filled with vapor and air. The pump, however, is unable to draw water up the rise until sufficient returns have accumulated to fill the return line and seal the bottom of the 45 deg. rise. When this occurs the pump operates until the seal at the bottom of the riser is broken and then stops. Vacuum is only produced to good effect

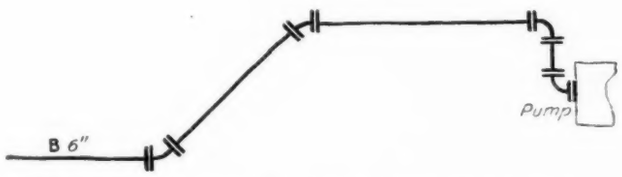


Fig. 1—The incorrect piping found at a rise in the return line

with your type of pump when your pump works on the water. Do you see the point?"

"Certainly, now that you name it," we told him. "If we could only keep the bottom of the rise sealed, the trouble would be fixed."

"That's just what should be done. We'll create a pocket that is always full if any returns are coming back. It's simple with a special fitting we can provide you. It is hardly worth while to buy only two of the fittings, however, so I'll show you how to make them of standard fittings."

He sketched the fitting shown in Fig. 2 and then explained it.

"The line is 6-in. pipe so take two 6-in. flanged tees. Put the side outlets on the mains. Put a plugged flange for cleanout purposes on the bottom of the lower tee, then long thread a 5-in. pipe into two 6x5-in. reducing flanges. When the whole arrangement is made up, the 5-in. riser line will extend nearly to the bottom of the

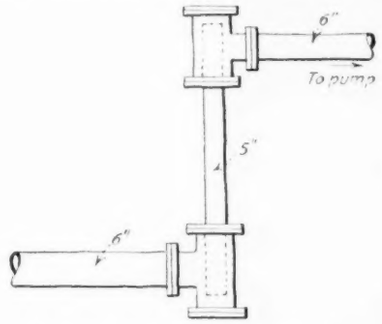


Fig. 2—Fittings made up to correct the piping shown in Fig. 1

incoming return and above the center of the upper horizontal line.

"The bottom tee thus forms a pocket for rapid accumulation of water to keep the riser sealed. The extension of this riser into the upper tee prevents returns once lifted from draining back. Remember that a rise of more than 6 ft. should be made in two steps or more."

Now what do you think of that for a simple solution of something that we did not even know was wrong? We called our boss pipefitter, provided him with a sketch and had him get going then and there.

"All right, what's next?" we asked. This thing was beginning to look interesting.

"While we are on changes in level on the return, let me show you another similar condition. You drop below the floor at several doorways and come back up again after passing them."

"Right," we said, and checked the places on our layout. They all, as it happened, were 2-in. lines at these points, and easy to change.

"Well, here's the way to fix them as an alternate to using the lift fitting. I'll show an elevation," and again he drew his sketch, Fig. 3.

"It's best to put plugged tees at the low points as I have shown," he said. "Put tees at the floor line on each side of the door. Reduce the riser to one-half the return size, or 1 in., and run this 1-in. line over the doorway and down to the return again. It's well to put a valve in one corner, at the top, so you can close off this line if you wish, but remove the handle and leave it open. This smaller line vents the pocket in the return and allows it to fill with water.

"And right here is a point I want to emphasize to you. We are making these sketches here in the office from known conditions as shown by your layout. All you have to do now that you have the layout is to furnish such sketches to your pipefitters whenever you want changes or additions made. Instruct the pipefitters to change nothing without the sketch, to work exactly to the sketch, and to return it marked complete for your

TABLE I.—RADIATION IN SQ. FT. THAT MAY BE SUPPLIED THROUGH PIPE RUNS OF VARIOUS SIZES AND LENGTHS, ASSUMING ONE LB. PRESSURE DROP

Dia. of Pipe	Length of Run in Feet									
	100	200	300	400	500	600	700	800	900	1,000
1¼	340	240	200	170	150	140	130			
1½	560	400	320	280	250	220	210	190	180	170
2	1,200	880	700	620	550	500	460	430	400	380
2½	2,400	1,700	1,400	1,200	1,070	980	900	800	730	700
3	4,000	2,800	2,200	1,900	1,800	1,600	1,450	1,350	1,300	1,250
3½	6,200	4,400	3,400	3,000	2,600	2,400	2,200	2,100	1,900	1,800
4	9,200	6,500	5,300	4,600	4,100	3,700	3,400	3,100	2,900	2,700
4½	12,000	8,500	7,000	6,000	5,300	4,900	4,500	4,100	3,900	3,700
5	17,000	12,000	9,000	8,000	7,000	6,500	6,000	5,600	5,300	5,000
6	26,000	18,500	15,000	13,000	11,500	10,500	9,700	9,100	8,600	8,200
7	39,000	27,000	22,000	19,500	17,500	16,000	14,700	13,800	13,000	12,300
8	52,000	37,000	30,000	26,000	23,000	21,000	19,000	18,400	17,000	16,500
9	78,000	55,000	42,000	38,000	34,000	30,000	29,000	27,000	26,000	25,000
10	100,000	70,000	57,000	50,000	45,000	40,000	38,000	36,000	34,000	32,000

transposition to the master layout as soon as their work is done."

There was a real point! It constituted successful control of the system. It brought this control to the office. The return riser and the door jobs were the start of our pipe line control. A control that we now have working on all of our lines, air, oil, gas and water as well as steam—but our engineer friend was talking again.

"I found another condition just outside the offices in your old buildings. Really, you fellows ought to be ashamed," and he laughed. "Let us see if it shows on

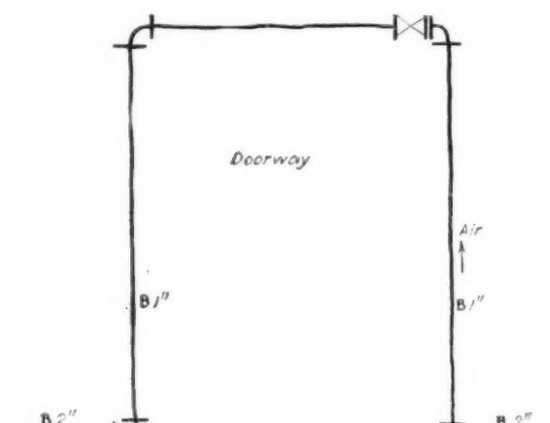


Fig. 3—Method of piping return line around a doorway

the layout—yes, sir, here it is." He pointed out the condition shown in Fig. 4.

And certain as we live we had missed it entirely. Our low pressure 6-in. main supplying the offices was interrupted with some 50 feet of 2-in. line acting as a first-class choke. It was there as a result of using the old 6-in. main to feed from one end to the office the previous year; before that the reducer had been located to feed both ways from where the 2-in. line now stood. It was evident that the pipefitters had simply connected with the 2-in. line when the reducer was removed. Of course we were ashamed, and we said so.

"No need to worry, gentlemen," he said. "I have found that condition in so many plants that it has become an old story for me. Funny though, you took the news nicely. Some engineers actually get angry that I should point it out. I find a lot of things that can be easily fixed but that create a lot of trouble in the average in-

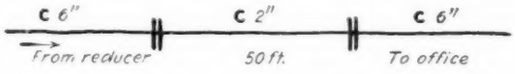


Fig. 4—Run of 2-in. pipe found choking a 6-in. supply header

dustrial plant. And all that's really needed to point out the trouble is to have a layout such as you have made."

"You certainly are right," we said, "and this thing is getting more and more interesting. What have you next?"

"Next? Well there are a number of things, but let me go out and see how the riser job is progressing. Before I go, however, here is a table I will leave with you that is useful in checking over pipe line proportions. You might look it over and I will explain it when I return."

We looked it over as he directed but did not get anywhere in particular with it. In fact, we were wondering what it was all about when he came back to the office satisfied with the work our pipefitters were doing. Incidentally, the service this engineer was rendering was more thorough and more constructive than any we had ever experienced.

"The pipefitters are getting along nicely. Now let us see the table and we will check the size of a sample line to illustrate its usefulness. It shows the theoretical amount of radiation that can be supplied by pipe lines of various sizes and of various lengths when the pressure drop through the line is limited to one pound. It is based on the well known 'One pound uniform drop' table and on the theoretical condensation of 0.30 pound of steam per hour per square foot of radiating surface.

"Understand that this table is theoretical. If the room

TABLE II.—SIZE OF RETURN PIPE REQUIRED BY VARIOUS AMOUNTS OF RADIATION

Pipe Size	Length of Return Pipe in Ft.									
	100	200	300	400	500	600	700	800	900	1,000
¾	560	400	320	280	250	220	210	190	180	170
1	1,200	880	700	620	550	500	460	430	400	380
1¼	2,400	1,700	1,400	1,200	1,070	980	900	800	730	700
1½	4,000	2,800	2,200	1,900	1,800	1,600	1,450	1,350	1,300	1,250
2	9,200	6,500	5,300	4,600	4,100	3,700	3,400	3,100	2,900	2,700
2½	17,000	12,000	9,000	8,000	7,000	6,500	6,000	5,600	5,300	5,000
3	39,000	27,000	22,000	19,500	17,500	16,000	14,700	13,800	13,000	12,300
3½	78,000	55,000	42,000	38,000	34,000	30,000	29,000	27,000	26,000	25,000

temperature is below normal the condensation will be more rapid, also the table is based on straight smooth pipe without bends. Both factors make the figures in the table low. However, we will use it as it stands.

"In your factory building there is a pipe run 600 ft. long from reducing valve to the end radiator. Every hundred feet along this line there is a riser feeding 200 sq.ft. of radiation, making a total of 1,200 sq.ft. of radiation. From the column in Table I corresponding to the total length of the branch (600 ft.), pick out the figure nearest to, but not less than, the 200 sq.ft. of radiation at the end of the line. The pipe size 1½-in. at the left is the size of pipe for the end of the line. The next hundred feet of the run supplies 400 sq.ft. of radiation and its size (2-in.) may be found similarly from Table I by picking out from the column corresponding to the total length of the branch (600 ft.) the figure

nearest to, but not less than, 400 sq.ft. Following this procedure the whole line may be proportioned.

"Assuming the supply piping to have been correctly proportioned a safe rule is to make the diameter of the return branch not less than one-half the diameter of the corresponding supply line. It may, however, be easier to follow the same procedure as with the supply line using Table II.

"Remember these two tables are theoretical and that you should accordingly be liberal in your allowance of pipe sizes. I suggest that you let the proportioning rest now until I have told you of a condition that should be corrected in order to balance the pressures coming back to the return lines."

Maintenance of Boiler Room Equipment

UNFORTUNATELY, the advantages of high-class boiler room equipment maintenance are not appreciated fully by some operating engineers and the result is that failures and service interruptions are occurring constantly and maintenance expense is extremely high. Where the maintenance is performed in a systematic manner and frequent inspections are made to prevent service interruptions, it will be found that the cost of this program will result in a large dividend of fewer failures and lower maintenance expense.

This fact is considered of such importance by a large central station in the Middle West, that the boiler room equipment is not only inspected and maintained on a definite time basis but at every opportunity where it is possible to do so. This has resulted in the elimination of defects that would result in service interruptions and a decrease in the maintenance cost per ton of coal fired.

In this plant there are eight B. & W. cross drum boilers with 17,260 sq.ft. of heating surface each and operating at 330 lb. gage steam pressure. The superheaters are of the B. & W. interdeck type. Each boiler is equipped with two B. & W. forced draft chain grate stokers, each having 202 sq.ft. of grate surface. The furnaces are of the American arch construction.

This equipment is given a thorough inspection and overhauling once a year and such other inspections and maintenance are performed whenever the conditions of service will permit. The boilers are fired with fifth vein Indiana coal having 39.67 per cent of carbon, 35.45 per cent of volatile matter, 12.79 per cent of moisture, 12.09 per cent of ash and 10,580 B.t.u. The coal is tempered in the bunkers by means of cold water sprays so that approximately 3 per cent of moisture is added.

During the first four months of 1927, 61,004 tons of coal were consumed, in 10,788 steaming hours and 5,485 banked hours. During this time the boilers were being operated at an average rating of 175 per cent. They are fired at a constant rating where possible and one or two are used to take care of the ordinary load fluctuation.

The forced draft is controlled by zone and main dampers, with most of the control being obtained by hand regulation of the main damper. Secondary air is injected with steam jets through the side walls at the arch throat.

The furnaces are given very careful attention and repairs more or less extensive in nature are made from time to time. Since arch tile of various compositions has been tried to eliminate spalling and lengthen their life, it is rather difficult to give the actual life of a furnace as a whole.

However, it can be said that the life of the front arches is about 9 months and the rear arches about 15 months. The life of the unventilated side walls and the dividing walls is about 8 months. All furnaces are relined with gunite after each run of from four to six weeks.

The boilers and superheaters do not show any signs of corrosion and the replacement of parts has been negligible except for two boiler tubes in which scale had deposited from raw water condenser leakage. The water boxes installed on each side of the stokers have given considerable trouble from warping and moving in toward the fire.

It has not been necessary to replace any of these but it was found necessary in a number of instances to jack them back into their proper position.

The stokers have given very little trouble. Occasionally the chain will buckle and the links will break but most of the maintenance was on a stoker that had a twisted front shaft.

The accumulative maintenance cost per ton of coal consumed from January 1st to April 30, 1927, is shown in the accompanying tabulation.

CUMULATIVE MAINTENANCE COSTS PER TON OF COAL CONSUMED JANUARY 1st TO APRIL 30th, 1927

Item	Costs	Tons of Coal Consumed	Cost per Ton of Coal Consumed, Cents
Boiler and superheater maintenance	$1,635.81	61,004	2.68
Boiler and superheater cleaning	1,203.00	61,004	1.97
Maintenance of furnaces and settings	5,689.41	61,004	9.32
Maintenance of stokers and stoker drives	1,018.00	61,004	1.67
Maintenance of soot blowers	1,456.82	61,004	2.38

THE SOUTHERN CALIFORNIA EDISON COMPANY recently found it necessary to acquire an additional tract of land at Long Beach and to prepare for a steam plant, of 1,000,000-kw. ultimate capacity. This required the relocation of two steel fuel-oil tanks each having about 1,300,000 gal. capacity. It was necessary to move these tanks about 1,000 ft. over a sandy, nearly level plain. The engineers of Stone & Webster adopted the novel plan of constructing two dykes about four feet high and 100 ft. apart and extending the entire distance from the old to the new location of the tanks. The space between these dykes was then filled with water to a depth of twenty inches and the tanks were easily floated in this artificial pond the entire distance of 1,000 ft.; by drawing off the water they were gently settled on their new foundation, which had been prepared before the pond was filled, all without straining the tanks and without starting any leak whatever in them.—*From a description in the Stone & Webster Journal, August, 1927.*

RELIABLE DATA INDICATE that the composition of iron—that is, the varying amount of carbon, phosphorus, manganese, sulphur, silicon, oxides, slag and copper usually found in wrought iron and soft steel—makes very little difference in the amount or character of corrosion under water. This refers particularly to the depth of corrosion commonly known as pitting. The location and depth of pitting seem to be mainly determined by variations of potential on the surface of the metal, principally due to the mill scale in irregular patches found on the surface of rolled iron or steel. It has been found by experiment that the useful life of a pipe as measured by the time to perforate is materially increased by removal of all mill scale and rust.

How One Plant Handled Its Operating Records

By J. J. Neville

SOME years ago I was employed as combustion and test engineer for a large soap and oil refining company in Chicago. We had a system of keeping records and costs on the boiler and engine room equipment that was especially complete. In order to comprehend the system better, a brief description of the power-plant layout will be given.

In the boiler room there were fourteen 5,000-sq.ft. stoker-fired water-tube boilers of three different types set in two rows. On one side high-pressure steam was generated and on the other low-pressure steam, the two lines being cross-connected through a reducing valve. The boilers were controlled by hand.

The pumproom, adjacent to the boiler room, contained four double-acting feed pumps, the piping of which was cross-connected with the high- and low-pressure steam lines, so that any or all pumps could feed to either the high-pressure or the low-pressure boilers. These pumps were also piped so that water could be fed through the heaters (which were of the closed type) or to the boilers direct.

Above the feed pumps, set up on a platform, was a tank that held a week's supply of feed-water treatment solution. this was handled by a small pump whose valve gear was connected with the rocker arm of the feed pump. In addition to the feed pumps there were two house service pumps, one boiler washout pump and two tank feed pumps.

On each boiler header was a flow meter, and a CO_2 recorder for each row of seven boilers.

All the boilers had draft gages showing the over-fire draft and the uptake draft. The forced-draft boilers also had draft gages showing the draft in the main blast duct to each boiler.

Both the low-pressure and the high-pressure lines carried recording steam gages. There was a recording temperature gage for the feed water to the pumps, one connected between the heater and the low-pressure boilers and another in the feed line from the heater to the high-pressure boilers. These recording gages were all set up on a panel above the operating engineer's desk.

The feed water to the boilers was pumped from one of two tanks that in turn were fed from returns throughout the factory from traps, closed coils in soap tanks, condenser returns, etc. The tanks were calibrated and a float arrangement attached to them. On the bottom leads from each tank, inserted in a thermometer well, was kept a standard calibrated thermometer. By looking at the float gage board, the cubic feet of water was noted; then by reading the thermometer in the lead to the feed pumps, one would note the temperature of the water and with this information could figure the actual weight of the water.

The coal was received on a side track and the cars unloaded by hand onto a conveyor belt. On the track belt conveyor was a small bucket conveyor set so that when the coal was dumped into the tank to feed the coal crusher, a certain percentage was picked up by the small conveyor and dumped into a small tank, from which samples were taken every night.

SHEET NO. 1

BOILER ROOM DATE

TIME	TANK	AMOUNT	TEMP.	REMARKS

SHEET NO 2

BOILER ROOM DATE

TIME	BOILERS IN SERVICE	BOILERS DOWN FOR REPAIRS	PUMPS IN SERVICE	HEATERS IN SERVICE	REMARKS

SHEET NO. 3

BOILER ROOM DATE

TIME	FAN IN SERVICE	WORK GOING ON	BOILERS BLOWN DOWN	REMARKS ON METER CHARTS AND METERS	REMARKS

SHEET NO. 4

ENGINE ROOM DATE

TIME	GENERATOR NO.1		GENERATOR NO. 2		GENERATOR NO. 3		REMARKS
	VOLTS	AMP.	VOLTS	AMP.	VOLTS	AMP.	

SHEET NO. 5

ENGINE ROOM DATE

TIME	ICE MACHINE NO. 1		ICE MACHINE NO. 2		ICE MACHINE NO. 3		BRINE PUMP 1		BRINE PUMP 2		BRINE PUMP 3		REMARKS
	SUCTION PRESS.	DISCHARGE PRESS.	SUCTION PRESS.	DISCHARGE PRESS.	SUCTION PRESS.	DISCHARGE PRESS.	SUCT. TEMP.	DIS. TEMP.	SUCT. TEMP.	DIS. TEMP.	SUCT. TEMP.	DIS. TEMP.	

SHEET NO. 6

ENGINE ROOM DATE

TIME	CONDENSER PUMP NO. 1	CONDENSER PUMP NO. 2	CONDENSER PUMP NO.3	ENGINE NO. 1	ENGINE NO. 2	ENGINE NO.3	REMARKS

Fig. 1—Boiler-room and engine-room daily log sheets for detailed information

There were two large engine rooms, in addition to which three buildings housed an engine apiece. The three isolated engines were taken care of by engineers who spent their time between the starting up in the morning and the shutting off of the engine at night by oiling up the shafting throughout the building they were assigned to. The two main engine rooms housed the ice

coal weight tickets, all charts from recording meters, both pressure and temperature, men's time cards, copies of all orders of the preceding day and any other information bearing on the costs of steam, electricity and refrigeration.

Coal unloaded during the day was figured from the scale tickets and the amount of water evaporated from

SEMI-MONTHLY REPORT

BOILER ROOM DATE

SHEET 2A

Cost of water evaporated	
" " coal burned	
" " rent	
" " insurance	
" " taxes	
" " depreciation	
" " repairs	
" " labor	
" " overhead	
" " petty stores	
" " drayage	
" " testing	
" " incidentals	
" " miscellaneous	
Total lb. steam generated	
Total cost of generation	
Cost of steam per 1,000 lb.	
Steam charge to engine rooms	
" " " soap dept.	
" " " oil dept.	
" " " heating	
" " " general	

Remarks —

Combustion Engineer
Chief Engineer
Manager

SEMI-MONTHLY REPORT

BOILER ROOM DATE

SHEET 1A

Total lb. water evap., actual	
" " " " F&A 212° F.	
Total lb. coal burned as fired	
" " " " dry	
Evap. lb. water per lb. coal, actual	
" " " " " F&A 212° F.	
Average steam press., high side	
" " " low side	
Average temp. of water to heaters	
" " " " " boilers	
" " " flue gas	
Factor of evaporation	
Total boiler hp. developed	
Hp. of boilers in service	
Per cent of rated capacity	
Average per cent CO_2	
Per cent boiler and furnace eff.	
B.t.u. value of coal as fired	
" " " " dry	
Per cent moisture; per cent ash; per cent sulphur	
Fixed carbon, volatile	

Remarks —

Combustion Engineer
Chief Engineer
Manager

DAILY LOG SHEET

BOILER ROOM DATE

Total lb. water evap., actual	
" " coal burned as fired	
" " water evap. F & A 212° F.	
" " coal burned, dry	
Evap., actual lb. of water per lb. of coal	
" F&A 212° F " " " " " "	
Average steam press., high side	
" " low side	
Average feed water temp. to heaters	
" " " " " boilers	
Average per cent CO_2	
Average hp. developed	
Hp. of boilers in service	
Per cent of rated capacity	
Factor of evaporation	
B.t.u. value of coal as fired	
" " " " dry	
Per cent moisture	
" " ash	
" " sulphur	

Remarks —

Combustion Engineer
Chief Engineer
Manager

DAILY LOG SHEET

ENGINE ROOM DATE

Total tons of refrigeration	
Total lb. condenser water	
Tonnage of compressors in service	
Per cent of rated capacity	
Average suction pressure	
Average discharge pressure	
Average brine temp. to coils	
" " " from coils	
lb. cond. water per ton of refrigeration	
Temp. of water to and from condenser	
Total kw. generated (D.C.)	
Average (hourly kw.) generated	
Per cent of rated capacity	

Remarks —

Combustion Engineer
Chief Engineer
Manager

SEMI-MONTHLY REPORT

ENGINE ROOM DATE

SHEET 4B

Total tons refrigeration	
Total lb. condenser water	
Tonnage of compressors in service	
Per cent of rated capacity	
Average suction pressure	
Average discharge pressure	
Average temp. brine to coils	
" " " from coils	
lb. condenser water per ton of refrigerat'n	
Temp. of water to condenser	
" " " from condenser	
Rating of ice machines	
Total engine hp. developed	
Total kw. generated, D.C.	
Total rating of generators	
Per cent of rated capacity	

Remarks —

Combustion Engineer
Chief Engineer
Manager

SEMI-MONTHLY REPORT

ENGINE ROOM DATE

SHEET 5B

Cost of condenser water (make up)	
" " ammonia (make up)	
" " brine (make up)	
" " rent	
" " taxes	
" " depreciation	
" " repairs	
" " labor	
" " overhead	
" " steam	
" " petty stores	
" " drayage	
" " testing	
" " incidentals	
" " miscellaneous	
Total tons refrigeration generated	
" cost per ton	
" kw. generated	
" cost per kw.	
Total engine power generated	
Total cost per engine hp.	

Remarks —

Combustion Engineer
Chief Engineer
Manager

Fig. 2—Daily log sheets giving average figures and semi-monthly report forms

machines, brine pumps, brine tanks, condensers, direct-current generators, service pumps, etc.

So much for the plant layout. I will now describe how the records were kept and the cost of steam determined. First there were the daily log sheets. For the boiler room see sheets 1, 2 and 3, and for the engine room sheets 4, 5 and 6.

These sheets were filled out every day by the engineers on duty and were delivered to the chief engineer's office every morning. I would receive these log sheets, also the daily log sheet. The average CO_2 for the 24-hour period was taken off the recording chart by a spiral planimeter. The amount of steam generated in the high-pressure boilers and that in the low-pressure boilers was determined from the flow meters. The heat value of the coal was received daily from the plant laboratory, a proximate analysis being made daily and an ultimate analysis every week as a check.

With this information at hand, I would enter on the boiler-room daily log sheet, Fig. 2, the average steam

pressure for the day, both high- and low-pressure, average temperature of the water to the heater, average temperature of the water to the boilers from the heaters, average percentage of CO_2 for the day, average flue-gas temperature, average temperature of the boiler-room air and the outside air. The total amount of water to the boilers was also entered and the total coal fed to the stokers.

Notation was made of the time each boiler was on the line and when blown down. The quantity of water was noted on the v-notch meter each time so as to make allowance for blowdown. The approximate coal analysis was entered on the daily log.

The daily log sheet, after being looked over by the chief engineer was signed by him and returned to me, and after checking any comments, I filed it.

Semi-monthly the record reports were filled out (see sheets figures 1, 1a and 2a for the boiler room). It will be noted that all the information on sheet 1a (with one exception) was taken from the daily log sheets. The one exception was that semi-monthly the coal height was measured in the bunkers. Having the height of the coal in the bunkers from the last report, with the height at the present report, the difference was noted. Add to this the amount of coal unloaded during this period and the result is the total amount of coal burned.

On sheet 2a the cost of steam was figured on a 1,000-lb. basis. Variable costs such as labor, material, repairs, incidentals, etc., and the constant items such as rent, insurance, taxes, depreciation, etc., were received the morning of the day that the semi-monthly report was to be made out. This report was made out and on the chief engineer's desk by noon. If everything was O.K. he signed the reports, after which they were then sent to the superintendent's office and later filed.

For the semi-monthly engine-room reports see sheets 4b and 5b. On sheet 4b the information given is a summation of the daily reports as given on sheets 4, 5 and 6. Form 5b is the cost sheet. Many of these items were practically constant. One of the big variables was the cost of steam used.

The writer figured these semi-monthly engine-room reports the same day that he figured the boiler-room reports and the same procedure for approval was followed.

To facilitate keeping track of all operations, there was a master drawing to scale of the ground and building layout, also auxiliary drawing of machinery layouts, piping layouts, etc. For instance, there was a layout of the high-pressure steam piping, one for the low-pressure steam piping, one for the exhaust-steam piping, one for water piping (hot and cold), one for ammonia piping, one for brine, one for each kind of oil piping, one for each branch of general piping, such as grease lines, acid lines, etc. These drawings were kept on file in the chief's office.

All machines such as pumps, stokers, engines, ice machines, generators, etc., were numbered. There were builders' drawings of these machines on file in the chief's office. In addition to the drawings a card index was kept, giving detailed information on each piece of equipment. For instance, the card for boiler No. 1 would show the size, kind and type of boiler, size of drums and tubes, thickness of sheet, size of and dimensioning of rivets, baffles, size and kind of safety valves, feed-line openings, steam-line openings, steam pressure carried and what stoker was under the boiler, detailed stoker information being given on a card marked "Stoker No. 1," in the file.

In addition to the card index system of general information, there was a test-card index system and a repair-card index system. Take a card from the test-card index marked boiler No. 1, and on it would be noted tests run on this boiler. The general test results only would be given on this card; for detailed information reference would be found to the card giving such data.

Furthermore, assume for example that information was desired on arches. Opening the test-card index file, one would turn to arches, where would be found the sizes of arches under the different boilers, heights above grates, width and length of arches, fusion temperature of the brick or blocks used in arch construction; boiler-test data with different arch positions, life of arches under various operating conditions, etc. In fact, anything that would be of interest concerning arches would be entered on the arch card. All cards in the test-card index file were equally complete.

In the repair-card index file was a card for each individual part of the machine, one for the complete machine and one containing a summary of repairs on all machines of that particular kind.

At first appearance it would seem that there was a lot of work in keeping up a system of this kind. However, in addition to keeping all the costs and data on the plant, as covered in this article, I also ran all the tests, kept drawings up to date, occasionally took the place of an operating engineer when one was off (having an engineer's license), and did other work around the plant.

One of the main things to watch in the keeping of a system of this kind is not to let it get behind. We are all human and the natural tendency is, when we drop behind, to hurry up, as it has become somewhat of a disagreeable task, the result being that mistakes are made. When mistakes are made, the system becomes useless.

Maintenance of Valves and Piping

By R. S. WILHELM*

AS THE demand for light and power increases upon a plant, the generating facilities must be modified to meet the new conditions. Until the year 1922 the prime movers in our plant were being operated at 155 lb. steam pressure, and from 50 deg. F. to 100 deg. F. superheat. The piping was of standard weight with screwed and special joints, and the valves, fittings and gaskets were satisfactory for the conditions under which the plant was being operated.

Early in 1922 a slight increase in steam pressure and superheat was found advisable, and as a result some of the piping and valves had to be changed. Although extra-heavy pipe and special joints were provided, it nevertheless happened that some fittings and flanges were used which caused several failures of a serious nature. The first was that of a 10-in. flange on a special joint while being tightened under erection. This was repaired by cutting a piece from another 10-in. pipe, having a similar joint, and using an extra-heavy screwed coupling. Another failure occurred when one of the 10-in. flanges of a 10x10x8-in. tee gave way and caused considerable damage. This tee was shipped to the manufacturer, who promised to advise us regarding the results of the exami-

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nation, but to date nothing has been received, although they were reminded on several occasions.

In 1925 the pressure was increased to 225 lb. per sq.in. and the superheat to 100 deg. F., which necessitated that the piping, valves and packing be changed. At this time all the high-pressure piping from 3-in. up was made extra heavy and special steel joints having long hub flanges and fastened with chrome-steel bolts were installed. Cast-steel valves were installed also and the expansion bends formerly made in the 12-in. pipe, were changed to two 8-in. bends with a Y-connection. A small portion of the original low-pressure 10-in. header was left, however, and in the early part of 1926, while replacing a gasket in one of the special joints, the flange failed and broke into three pieces. The failure placed us in a predicament because we could not spare the header for any great period of time. We searched our scrap pile and found the end of the pipe with the steel flange, the mate of which had been used in 1922. This flange was sawed into two equal parts and the two pieces of the broken flange were used to bolt the halves together for welding. The flange was installed in place on the pipe and welded, asbestos being used to prevent them from sticking to the pipe. This job was completed in about a half a day and has been operating satisfactorily to date.

The principal valves we selected for the new steam condition are given in Table No. 1.

When the piping was changed in 1922, we adopted a copper asbestos gasket. These gaskets caused considerable trouble and all had to be removed. This made us more cautious regarding packing, and as a result, considerable experiments were carried on before the gaskets and packings were decided upon for the new work.

TABLE I—DATA OF VALVES, TRAPS, ETC., IN USE IN THE POWER PLANT OF THE LAKE SUPERIOR DISTRICT POWER CO.

Kind of Valves, Traps, Etc., How and Where Used	Manufacturer
Main steam line gate	Crane and Lunkenheimer
Automatic non-return stop and check	Crane and Schutte & Koerting
Globe up to 3-inch	Crane, Kelly, Kelly & Jones, Lunkenheimer & Hancock
All exhaust lines controlled with gate valves from ¾-in. to 18-in. These are iron body valves with brass trimming and of the flanged and screwed types	Crane
Cold-water lines are controlled with gate valves. Valves of 2½-in. and above are of the iron body brass mounted type, whereas those of 2-in. and below are of the brass body design. In a few cases they are angle iron body valves	Lunkenheimer
Angle type blowoff	Everlasting and Yarway
In the feed-water lines bronze body globe valves and swing check valves are used for controlling and cast-steel gate valves for the shut off	Crane
Safety	Consolidated and Lunkenheimer
Strainers in suction lines for cold water makeup and air-pump lines	Elliott
Sediment strainers in water lines to bearing, seals, etc.	Crane
Throttle on main turbine units which is also used as an automatic emergency stop	Schutte & Koerting
High pressure, non-return tilt traps	Crane
Low-pressure, non-return tilt traps	Sarco
Bronze body swing check up to 3 in. on high-pressure steam and boiler feed lines	Crane
Iron body swing check on low-pressure and cold-water lines	Crane
Separators on the 10-in. high-pressure main to the main units	Hoppes, Crane
Cast-iron separators in the exhaust lines of the small engines	Crane
Reducing valves	Klippel, Leslie and Mason

The packing we have adopted as being best suited to our condition is given in Table II.

The valves and piping are maintained by a pipefitter and a handy man, who work under the supervision of the assistant engineer. They repair all valves and pipes and remove, replace and paint all pipe coverings when needed. Where it is impossible for these two men to perform any piece of work, additional help is obtained from the coal and ash handling gang.

All valves are inspected thoroughly twice a year and packed if necessary. The stems and threads on the gland studs are oiled and all leaks repaired as soon as possible after they develop. The twin and sediment strainers are opened, inspected and cleaned every three weeks by one of the assistant engineers. One of the ash handlers is responsible for all the painting of the pipe line. The pipe is painted gray, and a white arrow stenciled on the pipe shows the direction of the flow and a circle stenciled on the shaft of the arrow shows the contents and pressure.

TABLE II—DATA ON PACKINGS IN USE IN THE POWER PLANT OF THE LAKE SUPERIOR DISTRICT POWER CO.

Kind of Packing	Name	Thickness, Number or Style	Where Used
High-pressure sheets	Garlock	1/32 & 1/16 No. 900	High-pressure
	Durabla	1/32 & 1/16	High-pressure
	Johns-Manville service	1/32 & 1/16	High-pressure
Low-pressure sheets	Garlock	1/16, 3/32 & 1/8 No. 22	General low-pressure work exhaust and cold water
	Garlock	3/32 No. 619	Diaphragms
	Anchor Hydroil-sheet	3/32 & 1/16	Oil and hot water
	Palmetto	1/8 to 5/8 braided	Turbine controlling valves and general valve-stem packing
Coil	Garlock	No. 26	Centrifugal pumps, gate arms of waterwheels and plunger pumps
	Johns-Manville	No. 189	Same as Garlock No. 26
	John Crane	.....	Centrifugal pumps
	Durametallic	.....	High-pressure valve stems
Ring	Garlock	Rock hard	For combination in high-pressure oil, tar and compound pumping
	Garlock	No. 962	Metallic rings for turbine shaft packing and reciprocating steam rods
Manholes	Garlock	No. 604	.....
	Johns-Manville	Kearsarge	.....
Gage glass	Marvel	.....	.....

We carry one or more spare valves of each size of the gate, globe and angle designs, as well as a fair supply of seats and disks for valves up to 2-in. The value of our new valve and repair parts stock for valves up to 3-in. amounts to about $800.

Most of the maintenance expense has been in the replacement of gaskets. Then came the valves controlling the soot cleaners, the stoker dumps, small throttles and ash blowers, and these were followed by the steam traps and unions. Our total maintenance cost on piping and valves has been as follows:

Year	Total Cost	Cost per 1,000 Lb of Steam Produced
1923	$1,018.70	.....
1924	960.40	.....
1925	724.73	$0.0025
1926	513.09	.00176
1927 (first four months)	127.02	.00133

The decrease in maintenance cost has been brought about by the careful selection of the proper valves and gaskets for our operating conditions. The high maintenance cost in 1923-24 was due primarily to the failure of the copper asbestos gaskets, failure of the threads in the bonnets of some of the valves and the failure of a large number of check valves.

In Compounded Lubricating Oils there will be found more or less fatty acids. These are not active in attacking metal and so are harmless in this respect. They, however, do increase the tendency to form emulsions if water is present. In addition, in the presence of a small amount of moisture they may cause corrosion. Greases such as used to lubricate bearings will almost always show some degree of acidity. No corrosion will occur unless moisture has been present. It should be understood that fatty acids never are as dangerous as mineral acids.

EDITORIALS

F. R. LOW, *Editor*

John Quincy Adams

THE sudden death of John Quincy Adams, retiring president of the National Association of Stationary Engineers, comes as a shock to engineers throughout the country. Following upon the close of the National Convention and while the delegates were about to start upon the return trip from the Pacific Coast, the incident will serve as a sad reminder of what otherwise would have been a most enjoyable and memorable occasion.

Mr. Adams had given unstintedly of his time and self to the work of the N.A.S.E. His efforts contributed in a large measure toward making it better and stronger. Recognition was accorded last year by the members honoring him with the presidency. He was still a comparatively young man and, had he lived, his counsel would have been invaluable to the Association.

Discussion Better than Argument

SOME chief engineers hold weekly or semi-monthly meetings with their subordinates for the purpose of discussing in detail the various problems that are arising constantly in power-plant operations. This is an excellent idea, and if it is carried on in an earnest and friendly manner, it will afford a means for enlarging individual knowledge and tend to intensify the co-operative spirit.

These conferences should prove as beneficial to the chief engineer as to the other members of the organization.

Every man must be made to feel that his part of the work is as vital to the operation of the plant as the other fellow's, and there must not be any snobbish spirit of position superiority. Then ideas will be disclosed which will not only prove of value to the economic operation of the plant, but bring about a better relationship between the executives and the entire organization.

It is of vital importance that the talk should be in the form of a discussion and not an argument. There is a vast difference. An exchange of ideas in a friendly spirit provides an opportunity to learn something of value from others. The main object is to arrive at a mutually better understanding. If this is not accomplished, the purpose of the meeting is lost.

The emotions, especially temper, must be kept under control or else it will be impossible to decide on a worthwhile course of action.

It is essential that the meeting aim toward higher achievements. It is easy to revert to the discussion of insignificant subjects.

Things that should have been done a week ago without consulting anybody are saved by some men so that they will have something to say in these periodic conferences. Perhaps this is a result of the chief insisting that every man must have some subject to bring up at the meeting. This is an unreasonable demand. A man does not encounter difficulties every week or two of a nature to make them worth while talking over with a number of his business associates.

A meeting of responsible men costs considerable money, and its time should be devoted to baffling problems and to improving plant performance.

Your problems are fundamentally those of your associates. Their experiences or their ingenuity may show you the best course to pursue. Tell them your difficulties and listen to theirs.

The regular staff meeting can be made worth while, but somebody must see that it does not degenerate into a time-wasting routine.

Foreign Competition in Engineering

THIS country has been a land of boundless opportunity. Our industrial and engineering developments have utilized all the graduates that have left our engineering schools, as well as many from foreign schools who have emigrated to our shores. The demand still continues, but of late years the attendance of schools of engineering in the United States has decreased, owing partly to the stiffening of engineering courses, partly to the increased cost of education and to other causes.

On the other hand, word comes from European countries that attendance at their engineering schools has greatly increased and is still increasing. In fact, in some countries it is several times the pre-war attendance. At the same time opportunities in many of these countries are becoming fewer. There is an effort on the part of many of these graduates of European schools to emigrate to the United States.

This country would welcome the best of these young men and would be the gainer by absorbing these exceptional men in our industries. On the other hand, if large numbers of foreign students were admitted, regardless of ability, and if they worked for comparatively low wages, there would be a tendency to lower the salaries

in many branches of engineering and to decrease the opportunities open to graduates of our own schools. The foreign graduates stick closely to purely professional work, and this tends to divert many American graduates into the business side of engineering. The ideal, of course, would be the selection of candidates for admission under the quota on the basis of ability, but, obviously, this would be difficult to put into effect.

Water Power and Fish

WATER-POWER developments are frequently associated with other interests, such as navigation, irrigation, fish culture and municipal water supply. These combinations of interests vary in different parts of the country. In the Eastern sections navigation is a major problem, but in the West irrigation and fish culture often conflict with water-power development. All these interests are important to the general welfare of the public, therefore all are worthy of consideration. When two or more of these interests conflict, a problem is presented, of large importance if the most economic arrangement is to be obtained.

Fish culture in combination with water-power development has offered one of the most difficult of the joint interest problems. Water power in combination with navigation or irrigation is mostly a question of how to handle the water and when and to construct the necessary works to accomplish this end. Handling a live fish that is not partial to being handled and doing this without injury, is something that may not be so easy as a casual consideration might indicate.

As long as dams were low, a fishway could be provided that would allow easy passage of migratory fish over the dam. With some of the modern dams that approach a height of three hundred feet, the difficulty increases, and up to the present time no entirely satisfactory solution has been developed, although considerable progress has been made and a number of methods have given encouraging results. Opinion is divided on the feasibility of passing fish over high obstructions in rivers, but because a thing has not been done successfully is no reason why it cannot be done. In this problem, like in many others if the necessary study is put on it a satisfactory solution will be found.

In 1924 a committee was formed to represent the fish and power interests on the Pacific Coast in the hope of uniting these two factions and determining what could be done toward a solution of the problem. A report on the work of this committee was recently presented by the National Electric Light Association. It is obvious from this report that the amount of work done toward solving this problem has not been extensive and what would be expected for the comparatively short time serious consideration has been given to getting fish over high obstructions in rivers. The report, however, has many encouraging notes, and although, as is stated, the work has not passed the experimental stage, the future is promising, but it can be satisfactorily met only by the engineer and biologist working together in harmony. It would be difficult to say which is more important, a power or a food supply, since the latter may depend largely upon the former. Therefore it behooves our fish and power interests to work out their problems to obtain the most economical balance, that the best interests of the public may be served. All fish and no power may be an undesirable condition, but all power and no fish might be even worse. Why not have some of each?

Smoke Prevention in Small Plants

SMOKE prevention or reduction in small hand-fired plants, especially heating plants, is always a bone of contention in the fall of the year. With the beginning of the heating season and the starting of new fires, there is likely to be an unusual amount of what appears to be unnecessary smoke produced. This naturally creates a very unfavorable opinion of these plants in the community. For this reason it is desirable that the engineers and firemen use special care in starting their fires and in operating them thereafter. In addition, the owners or superintendents of these plants should also take sufficient interest in the operation of the plants to see that this is done.

Particularly in the building of new fires should care and attention be given, especially if bituminous coal is used. By starting the fire from above, that is, by placing the coal next to the grate and the wood or kindling on top, the fire burns from the top down with the result that a part of the initial smoke is prevented. And in the care of the fire, after it is started, much can also be done to prevent smoke, even though the furnace design and layout may not be ideal for smokeless combustion. The adoption of a better method of firing may help, while the use of another fuel, perhaps of the smokeless type, must be resorted to in some plants. It may also be found necessary to install air or steam jets which, although not economical in their operation, will cut down the smoke materially.

There is no satisfactory substitute, as far as smoke reduction is concerned, for a properly designed and constructed furnace. The down-draft type of furnace can usually be operated with little or no objectionable smoke. Stokers are also effective in preventing smoke, providing the furnace is properly designed and built, and the stoker selected, installed and operated as it should be. In addition to reducing smoke, investments in such equipment usually pay good dividends in more efficient plant performance.

Whatever the status of the plant, those in charge should make every effort to prevent the production of smoke. The community is entitled to, at least, this consideration.

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Alarms to Indicate Circuit-Breaker Operation

DURING the last few years automatic signals have been undergoing a process of development, and several methods have been devised to indicate circuit-breaker operation. In some installations quality and accuracy of service are sacrificed somewhat in order to decrease the expense, but in the larger central stations and substations expense is to a great extent subordinated to quality of

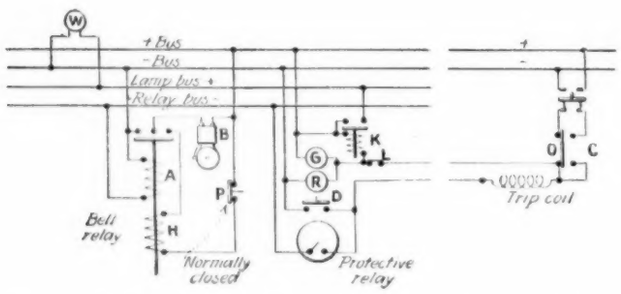


Fig. 1—Indicating and alarm circuits of system requiring only three control leads (lead for reclosing circuit breaker is not shown)

service. The two systems diagrammed in Figs. 1 and 2 represent the principles employed in most installations; there are, however, many variations of these. In some cases it is considered advisable to decrease the number of wires in control cables by the use of auxiliary relays, while in others extra pallet switches and conductors are used to reduce equipment and complications in the wiring of the system.

In Fig. 1 there are only three control leads—one for the indicating lamps and bell operations, one for tripping and one for closing the circuit breaker, the last not being shown. When the breaker is in the open position, the pallet switch is at *O*, and the circuits of green lamp *G* and relay *K* are closed. When relay *K* closes, the lamp bus is made positive and energizes lamp *W* to the negative bus. Lamps are used in this manner to indicate the opening of circuit breakers on a certain section of the power bus or buses, while the bell rings only when a circuit breaker is opened by protective relay operation. When the protective relay operates, the trip-coil circuit is established through the actuating coil *A* of the bell relay, which closes its contacts and causes the bell to ring. At the same time the circuit of holding coil *H* is completed through push button *P*, and the relay is held closed until the holding circuit is interrupted by pressing the push button.

In this system the lamp wire (the lead to *G* and *R* from the pallet switch) is positive when the breaker is closed and negative when the breaker is open. Therefore, if relay *K* were not used and the lamp wire were connected directly to the lamp bus, the opening of a second circuit breaker while the first was closed would cause the lamp bus to become negative while the lamp wire on the first breaker remained positive. So, either a relay must be used, as in Fig. 1, or an extra wire and contact on the pallet switch, as shown in Fig. 2, is necessary. The switch *L* on the lamp wire is to disconnect lamp *W* when the breaker is opened intentionally. It also de-energizes lamps *R* and *G* so the operator will not forget to close this switch when placing the breaker in service again after being open. Otherwise there would be no indication that the circuit was not complete, but the alarm would not operate if the breaker opened.

In Fig. 2 relay *K* is omitted and an extra wire is used to the pallet switch, which has an added contact. There is no relay bus, but a bell bus is used which is energized when any circuit breaker trips, either by operation of the protective relays or otherwise. Lamp *W* is energized directly from the pallet switch, which also actuates the bell relay; this relay has only one circuit and is used to insulate the main bell bus from the lamp bus. The switch *L* serves the same purpose as in Fig. 1, but also stops the bell from ringing, thus eliminating push button *P*. These diagrams are for push-button control, and

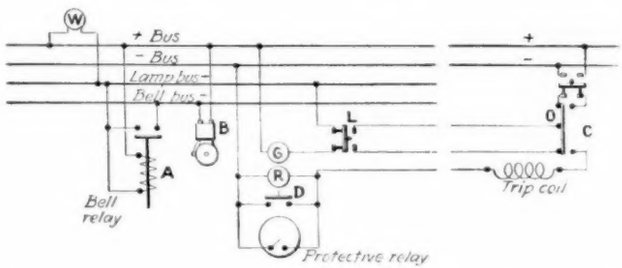


Fig. 2—Circuit of Fig. 1 simplified by omission of relay, but requiring four control leads

where control switches are used, switches *L* can be operated mechanically with the control switch contacts to simplify operation.

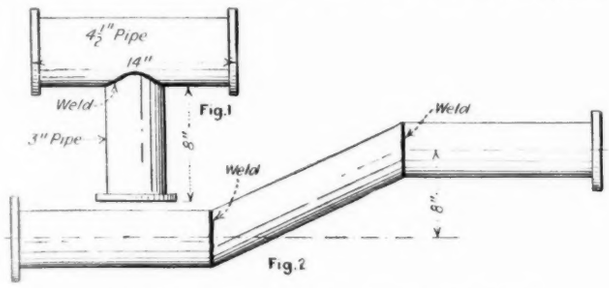
The advantage of the first system is that the bell will ring when the protective relay circuit is closed, and indicate trouble should the breaker fail to open because of mechanical faults. In the second system, however, the bell will ring whenever the breaker opens, and is not dependent on protective relay operation, as in the circuit shown in Fig. 1.

E. H. STIVENDER.

Los Angeles, Calif.

Some Uses for Welding in the Power Plant

AFTER some years of service a regulating valve on the cold-water line supplying an open heater wore out, and instead of repairing the old valve, we put in a new one of a different make. As the new one was shorter from end to end than the old one, the tee in the line would not fit, so we decided to make one. We took two 4½-in.



Special tee and offset pipe made by welding

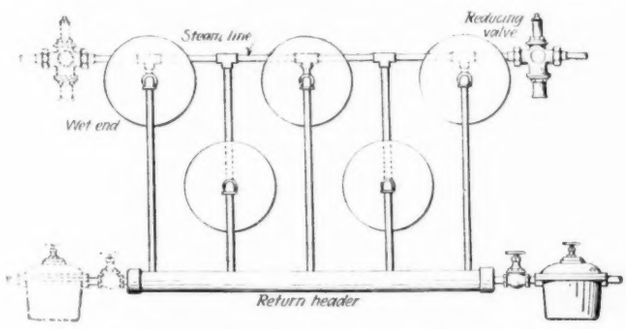
flanges and a 14-in. piece of pipe threaded on both ends and put the flanges on. Then we obtained an 8-in. piece of 3-in. pipe and flange, and after cutting an opening in the 4½-in. pipe in the center, we welded the 3-in. pipe into it and so made the tee shown in Fig. 1.

Some time later, when installing a new pump, the two steam lines were about 8 in. off center and the pipes could not be turned so that the elbows would face each other nor could we use two 45-deg. elbows. Instead of attempting to bend the pipe, which was only 5 ft. 2 in. long and 4 in. in diameter, we measured the centers to see how much out of line they were and then we cut the pieces of pipe according to measurements and welded them in place, the finished pipe being shown in Fig. 2.

Seattle, Wash. J. B. WILLIAM.

Drier Operation Was Improved Through Correct Drainage of Condensate

IN A dyehouse two large driers for yarn drying were operated together, but one could not maintain the production of the other and it was suspected that the trouble was due to imperfect drainage of condensate



Arrangement of drier with steam and condensate connections

from the slow drier. Both discharged to a common trap, and to improve matters individual traps were placed on each drier. Some improvement was effected, but still the management was not satisfied with the production.

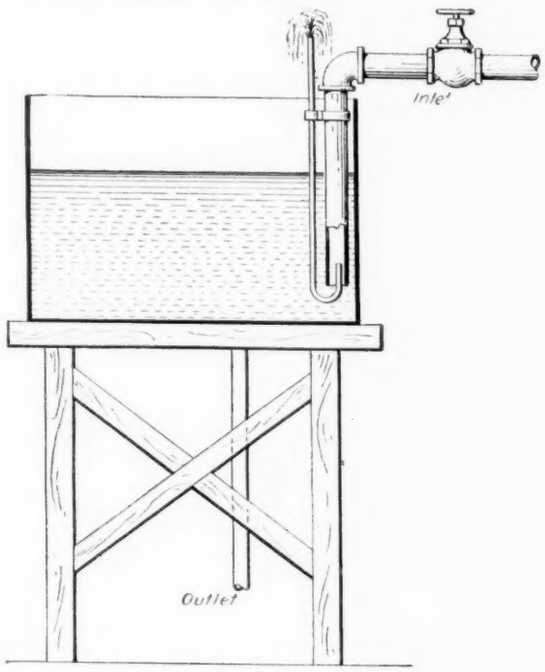
I looked the machines over and found the piping to be as shown in the sketch. The drier cans at the wet end of the machine were connected to the trap by long return lines with several bends, while the dry end was connected by short lines, which were the source of the trouble. Likewise, the reducing valve was at the dry end, which had a tendency to give the cans at that end slightly greater pressure. Thus the pressure on the trap was that existing in the nearest drying cans, which, being a little above the pressure at the wet end, tended to hold the condensate in the farther driers till a hydrostatic head was built up in the return line to overcome the difference in pressure.

Moving the trap toward the wet end and the reducing valve also, equalized the pressure drop in the piping, and with a prompt removal of condensate from all cans in the drier the production increased considerably.

Thompsonville, Conn. G. H. HART.

Flow Telltale for Water Tanks

EVERY now and then we run across, in our travels, some labor-saving kink that seems too good to keep covered up. In the power plant of the company by which I am employed, the engineer was faced with the problem of keeping check on the flow of water from an auxiliary



Fountain-like jet shows when water is flowing in to tank

supply to a storage tank. The tank supplied a small pump, which in turn delivered water to a tank and was in the nature of an emergency service.

The tank was at such height that gage glasses and other customary level indicators would not have been convenient. The illustration shows how this engineer provided a cheap and foolproof telltale.

Water leaving the inlet pipe had quite a velocity, and by utilizing this velocity as pressure he was able to see at all times whether water was flowing in or not.

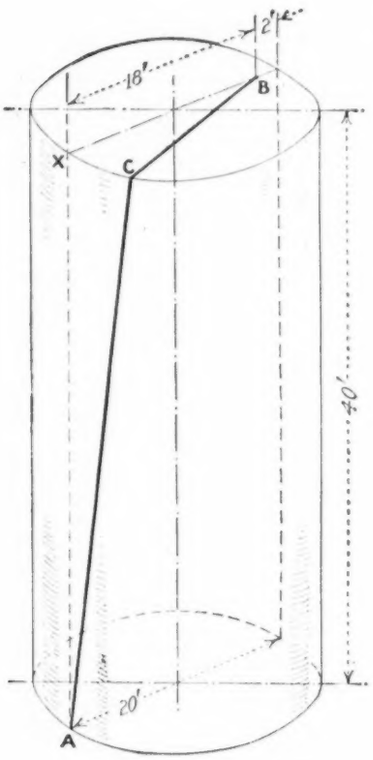
The indicator is a length of ⅜-in. brass pipe bent as shown and of a height sufficient to show its discharge above the tank top. The bubbling, fountain-like jet shows from any reasonable distance whether the tank water supply is on or off. C. E. COLBORN.

Jeannette, Pa.

COMMENTS *from* READERS

How Long Is the Line?

MANY of us have been interested and instructed, and some of us, alas, have been embarrassed, by the "What do you know?" questions in *Power*. Mental exercise is just as important as bodily exercise and it is just as well to puncture our conceit now and then.



Locating the shortest line

Along the same line the readers of *Power* may be interested in the problem outlined in the illustration, which, in spite of its apparent simplicity, makes a lot of trouble. It is desired to find the minimum length of a flexible wire run on the outside of a tank from point *A* to *B*, as shown in the sketch. The tank is a perfect cylinder 40 ft. high with flat ends 20 ft. diameter. Point *A* is at one end of a bottom diameter and point *B* is two feet from the other end of the corresponding top diameter.

The simple course from *A* to *X* and then to *B* gives 58 ft., but a string placed along that path on a small model will show a lot of slack as soon as it slips away from the diameter on which *A* and *B* are located to some other point, as at *C*.

I figure the shortest distance to be 52.33 ft., but perhaps some reader can economize on this and discover an easy way to calculate it as well as to locate the point *C* in terms of the angle *XBC*. E. S. SMALL.

Oak Park, Illinois.

* * * *

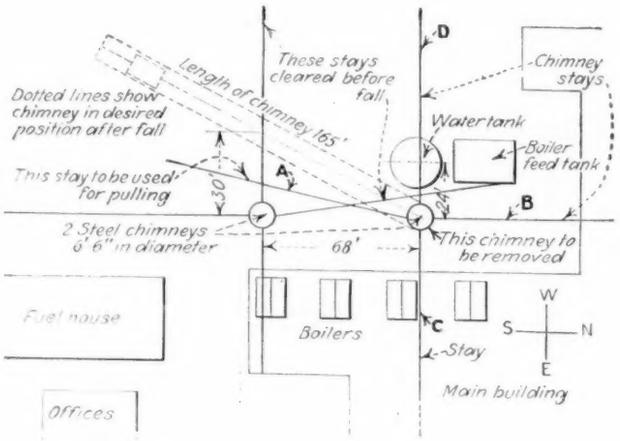
How Would You Do It?

REFERRING to the inquiry of Ronald Simmons in the Aug. 9 issue, as to the best method of razing a chimney, I have never "dropped" a chimney of 165 ft. in height, but about nine years of my twenty-three in the engineering line I spent in the Far West and in Mexico, and had to handle heavy "gin-poles" and other awkward pieces of machinery by methods that are generally described as "steady by jerks."

The line of desired direction of fall of this chimney is approximately due southwest, and my suggestion for doing the job is as follows:

Choose a day on which there is practically no wind or, if any, a wind from the southwest against the direction of line of fall. Take stay wire *A*, indicated on the sketch submitted and reproduced herewith, and without lengthening it, fasten to it, by means of clamps, the top block of a single-sheave block and fall and the lower block to a dead man placed a fair distance away and on a general angle of 25 or 30 deg. to the line of fall. Next cut stay *D* and do the same with it as with stay *A*. Put a couple of men on each tail rope and take a steady strain, as equal as possible on both stays. Then fasten the lower part of the chimney above where it is to be cut, using another block and fall to a dead man sunk in the ground in the direct line of the desired direction of fall of the chimney, put the block and fall under strong tension and snub it there. This will hold the bottom of the chimney in position while it is being dropped.

Then start on the northeast side of the chimney, cutting right and left at the center line with a blow-torch, and at the same time have the men on the fall rope of each stay, *A* and *D*, increase the pull as the cut is made. This will cause the chimney to take the desired direction of



Plan showing position of chimney relative to surrounding objects

fall, and give the man cutting the chimney with the torch ample time to get out of the way. With this method it will be unnecessary to go to the trouble of bolting straps across the kerf in order to hold the chimney upright while the cut is being made as proposed by Mr. Simmons in his inquiry.

As the chimney starts to fall, if he has a couple of good lively men on the blocks and falls fastened to stays *A* and *D*, the chimney can practically be steered to almost the exact spot wanted and without danger of damage to the adjacent buildings or water tank. A. O. KELLOGG.

New York City.

The Decrease in Students in Mechanical Engineering

REFERRING to the comments of Charles MacCabe Smith in the July 12 issue on the "Decrease of Students in Mechanical Engineering," he presents a viewpoint mellowed by success in another field.

The recent graduate must, indeed, be possessed of more imagination and less logic than granted him by Mr. Smith to expect an immediate salary equal to that of a senior executive. But he does expect, and justly so, to be considered economically and technically more than a tracer.

An engineer's training is necessarily wide, encompassing many fields, and for that reason stimulating. It does not stifle the imagination as Mr. Smith claims, but rather imposes upon it the control that technical sobriety demands. Logic and imagination are not mutually exclusive. It is this very preparation that enables him to master the details and problems of his specific field more quickly than a lesser trained man and to envisage the relation of his field to allied ones. His solution of problems is a rational growth and not an application of a series of formulas whose underlying theory and nature are unknown to him.

He is, therefore, something more than one "who can use his slide rule accurately," and who can "readily learn to find the engineering data in his handbook." As for his ability as a draftsman, he is, from my experience, not so lacking in a "sense of proportion and a little artistic taste,"—at any rate as much as is generally cultivated at present.

The recent graduate's discouragement is due to paucity of engineering positions and low remuneration. The former condition is surely affected by a decrease in students, and nothing further need be said on that score. As for the latter, it is due, not to incompetency, but in a large measure to the general low level of salaries commanded by technical men. The only way to remedy this condition is to evaluate correctly, in the light of the other professions and trades, the economic and social importance of the engineer.

B. L. SPIVAK.

New York City.

* * * *

The Consulting Engineer

THE editor of *Power*, in the Aug. 23 issue, analyzes the consulting engineer and appears to relegate him to the scrap heap. Referring to the last sentence of the editorial: "It will be interesting to watch whether consulting engineering will continue an attractive profession or whether this work will be taken over entirely by the larger organizations."

The right kind of a consulting engineer will not be the "young engineer" just out of colleges, but the experienced man acquainted with the operation of power plants, equipped with the intestinal fortitude to tell his client the truth, and design plants accordingly. He will be the man equipped by experience to analyze situations on a dollars and cents basis and at the same time having the sales ability to market his services. He will be a man who thinks in B.t.u's. and not in kilowatt-hours or superpower plants or superpower engineering.

He will be the man experienced in thinking in terms of small units, who can take the exhaust from small units and salvage the heat which the superpower plant must throw out. He will be a heat-study engineer and not primarily a student of electrical production. Kilowatt-hours will be merely incidental, and when they can be purchased cheaper than he can produce them, the electrical companies will get the business. He will think of the total cost of all services in a property and not allow the electrical requirements to dominate the situation.

This consulting engineer of the future will be a man the financial interests will employ co-incident with the retaining of architects to plan their boiler plants and general service equipment—a man who, from his knowledge of actual plant requirements, will build real revenue producing plants into properties and not fit cast-iron and low-pressure heating boilers into the low-head-room and congested boiler rooms so common in the buildings and hotels of today.

He will design block plants to serve an entire block or greater areas, eliminating many smoke-belching, low-efficiency plants which now take up valuable space and eat up the owner's money.

This engineer will write specifications with teeth in them, guaranteeing to the owner, certain predetermined efficiencies and results. He will be the man to decide the question of purchased service. He will insist that estimates of service companies be made into guarantees and include clauses in service contracts which will return the plant intact to its original condition if such guarantees are not met.

Industry cannot afford to allow the consulting engineer to pass out of the picture. Industry, the hotel or any plant requiring heat for its buildings or steam for process work, needs a level-headed consulting engineer who can keep all the essentials in view and make intelligent unbiased comparisons between purchased and produced service.

The editor is right as to specializing and, no doubt, the consulting engineer of the future will be more of a specialist. The manufacturing concerns will always maintain a staff of engineers to supply so-called free engineering and give advice; but these firms are certainly not unbiased and engineers in their employ must sell their products if they want to continue on the payroll.

The large electrical operating concerns will also continue to maintain their own engineering departments, but when we consider that the plants of this type use only a small percentage of the total fuel, we believe the need of the consulting engineer will be in proportion to the money expended. The table herewith was used in an article by Egbert Douglas, entitled "Facts About Fuel Conservation," which appeared in the November issue, 1922, of *Industrial Management*, and while the quantities have changed to some extent, it shows the relative proportions of coal used:

	Per Cent
Steam railways	29
Industries—other than steel and coke plants	28
Coke plants—not including gas plants	16
Domestic consumers	12
Electric utilities	8
Steel plants	7
Coal gas plants	1

There appears to be an epidemic of consolidations by the various manufacturing concerns, and no doubt the future will produce companies who are prepared to supply all the equipment essential to plant operation. Such companies will be in position to design, install and operate their plants, but this does not eliminate the independent engineer, and the purchaser will do well to call in the outside man to check up on the free engineering of the manufacturer.

Aside from the design of new plants the field for supervision of smaller properties presents great possibilities. Many hotels and industrial plants cannot afford to pay the salaries of engineers competent to supervise their plants and in many cases the plant is too small to justify more than a small operating crew. In this case it pays the plant owner to place the property under the supervision of an engineer on a monthly retainer basis. This places the management in competent hands and relieves the manager from work which, in most cases, he does not understand and which interferes with his major duties.

We have been close to the operating situation for many years and in contact with many operating men. We believe we see a trend toward the employment of a consultant who speaks the language of the operating engineers. The consultant must be a man to whom the operating man can come for advice and a man who can command the respect of the operating man. This means that the consulting engineer of the future will spend his early days, after college, in a plant gathering experience and not leaning over a drafting board in an engineer's office.

The consulting engineer on power plant and heat problem matters is here to stay, and all he needs is ability to sell himself and his services. He must crawl out of his seclusive shell and learn to speak the language a financier will understand.

CHARLES A. CRYTSER,
Chicago, Ill. Douglas & Crytser, Engineers.

* * * *

More About High Boiler Plant Efficiencies

IN THE June 28 issue Henry James expresses skepticism of some reported high boiler-plant efficiencies that voices the feelings of many engineers. Naturally, one cannot estimate the number of engineers who, in dividing the water evaporated during a period by the fuel burned, found themselves so far behind published results that there was established a fine variety of inferiority complexes. These need not worry, however. Should some of the published tests be carried over a longer period, say a month, a number of items that do not show up completely during a few hours' test will manifest themselves, and the feeling of elation may change to one of depression. Also, measuring instruments, meters and scales may be inaccurate. And it is quite possible to "kid" oneself in the interpretation of data.

Not long ago I read a report of a test on a small boiler carrying a heating load with an efficiency of 83 per cent. There was not any of the auxiliary apparatus, air-heater or economizer, that makes such efficiencies possible—just an everyday installation.

A few years ago, while engaged in the installation of a rotary kiln for the calcination of an earthy material, my suggestion that the kiln would make a good job of drying the material (which was then being dried in a monstrosity composed of vertical concrete chambers down which the material flowed over cascade baffles through the upcoming stream of gases from the furnace) was received patronizingly by the manager, who said, pointing to the aforesaid monstrosity, "Sandstrom, there is the most efficient drier in the world."

"What are you trying to do, kid me?"

"No sir. That drier evaporates 20 lb. of moisture per pound of oil."

"Not only impossible sir, but inconceivable!"

Evaporating 20 lb. of moisture from a temperature of 70 deg., per pound of 18,200 B.t.u. oil requires an efficiency of 122 per cent. And when it is considered that the material dried is heated from atmospheric temperature to about 400 deg., together with the loss by radiation, the efficiency approaches 150 per cent. Curiosity impelled me to make an Orsat analysis of the gases at the point where they enter the drier and I got 4 per cent of CO_2 and at the fan discharge 1.5 per cent CO_2. Yet the performance of this drier had been reported by someone as evaporating 20 lb. of moisture per pound of fuel. A calculation involving the output of the drier, the moisture content of the material, and the fuel burned during a period, gave results in harmony with the Orsa. analysis.

Some engineers are tempted to regard the theoretical capacity of the feed-pump as a fair check on boiler performance. In fact, I have personally met several that used this means of arriving at the work of the boilers. When we consider such factors as short-stroking, slip, and the leakage past the piston, one or more of which are found in most pumps and which can be given a valve to suit the engineer's fancy, the use of a pump as a meter seems ludicrous.

I have in my possession a report of six tests on oil-fired furnaces. The CO_2 runs from 5 per cent to 7.8 per cent, and the O_2 from 10.4 per cent to 15.8 per cent, the totals from 18.2 per cent to 20.8 per cent. These figures can be approximated in coal burning practice but it is ridiculous to say that it represents oil burning practice because the oxygen "disappearance" is far short of the actual. In one of the tests there was 5 per cent CO_2 and 15.8 per cent O_2, a total of 20.8 per cent. Such a total in the gases of an oil-fired furnace would represent nearly infinite excess air and the actual CO_2 content would be a fraction instead of 5 per cent.

Following is a paragraph from a report on the performance of a brick kiln. "It will be noted that at the maximum temperature there is a drop of only 390 deg. F. between the temperature of the gas coming into the kiln and the gas leaving the kiln. In other words, only 21 per cent of the incoming heat is actually utilized, the remainder going up the stack. If it were possible, on the other hand, to burn the kiln with just the theoretical quantity of air, then we should have a flame temperature of approximately 4,800 deg. F. If the stack remained 1,800 deg. F., we would be using approximately 69 per cent of the total heat."

If the foregoing were a practical method of determining efficiency, then air leakage between the furnace and the stack would reduce the stack temperature and increase the apparent efficiency—infinite excess air, infinite efficiency.

The man, who made the report quoted, received a salary several times that received by 90 per cent of the readers of *Power*, which proves that there is no necessary relation between engineering ability and good salaries.

After many years experience I would advise young men entering an engineering career (assuming that personal profit is the goal), to absorb just enough of engineering instruction to graduate, then cultivate what might be politely called a "divine affirmative," and success is assured. He need not concern himself about the actual work of engineering because there will always be an abundance of men to whom a bare living is satisfactory—an attitude resulting from pure love of the work, sometimes coupled with an absence of viscera.

Los Angeles, Calif. C. O. SANDSTROM.

New and Improved EQUIPMENT

Fairbanks-Morse Co. Builds High-Speed Diesels

IN MANY places in the power field the application of Diesel engines has been limited by the space occupied and weight of this type of prime mover. To meet the demand for a Diesel of light weight and higher speed for such service as power shovels, locomotive-type cranes, dragline excavators and similar services, Fairbanks-Morse Co. has developed a line of engines operating at from 500 to 800 r.p.m. These engines are also intended to meet the demand for small generating sets for installation in present power plants without the enlargement of the building.

The new engines are of the two-stroke-cycle airless-injection type and follow in general principle the lines of the larger Diesel engines built by this organization. The smaller series in ratings of 15 hp. per cylinder operating at 800 r.p.m. is built in 2,- 3- and 4-cylinder models, while the larger series, which is a modification of the standard marine line, uses a 30-hp. cylinder in models with 3, 4 and 6 cylinders.

In order to secure the maximum compactness, the cylinders of the 15-hp. cylinder size are cast in block. This construction simplifies the design in many ways. Water piping of any kind is unnecessary, and the exhaust header is applied in a simple manner. It increases the rigidity of the entire assembly and at the same time reduces the weight in pounds per horsepower. In many cases small engines are set on foundations that are not rigid, and this rigidity of construction then becomes an important factor in maintaining bearing alignments.

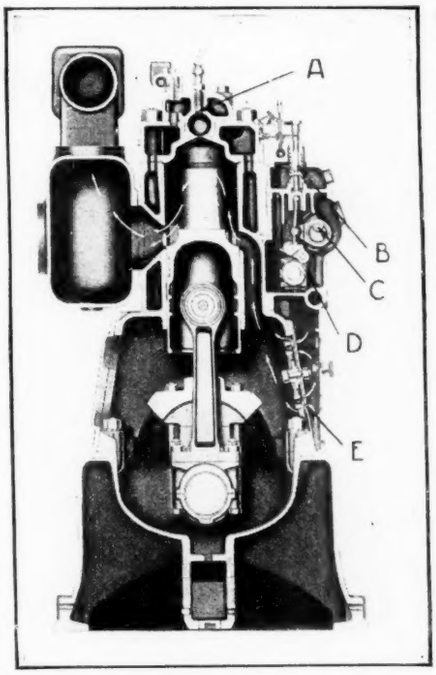


Fig. 1—Section through block cylinder design

A—Fuel-injection nozzle; *B*—Injection pump plunger; *C*—Governor control shaft; *D*—Injection pump cam; *E*—Air suction valve.

Another modification of the unit is direct connection of a small alternating-current generator with direct-connected exciter, as shown in Fig. 3. This is the first time that an alterating-current generator with Diesel drive has been available in sizes as small as 35 kw. Since this small engine is just as efficient as the large Diesel engines, the power user who has a comparatively small load can obtain the same economy as the user of a large amount of power. Where direct current is desired, these engines are equipped with a ball-bearing direct-current generator.

The lower base of the block design is of sturdy construction with heavy transverse bridges which form the main bearing supports. At the forward end of the lower base is a compartment which houses the gear driving the layshaft. This compartment also forms a sump for the clean lubricating oil. The shaft, which carries the idler gear of the layshaft train, also carries an eccentric which drives two plunger lubricating oil pumps.

The speed control is simple and will throttle the engine down to a low speed, and when the manual control regulator is turned suddenly to the full-speed position, the engine comes up to speed in the same way that an automobile engine speeds up when the throttle is suddenly opened.

The governor setting can be changed by means of a governor control wheel. When this wheel is turned through several revolutions, the governor setting is changed and the engine will operate under governor control at the speed corresponding to that particular setting.

The cams that operate the starting air valves and the injection-pump plungers

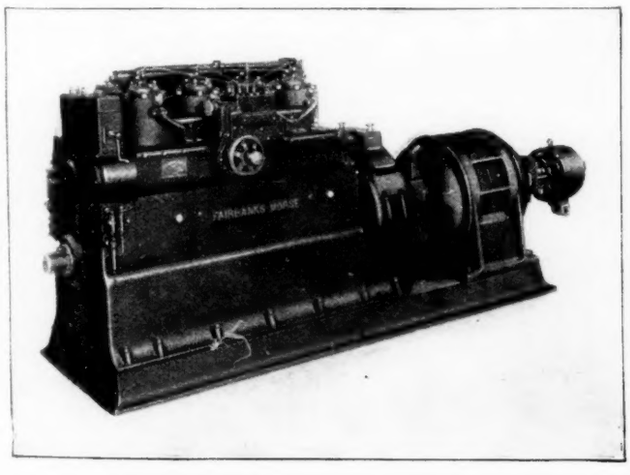


Fig. 2—Block design engine with direct-connected a.c. generator and exciter

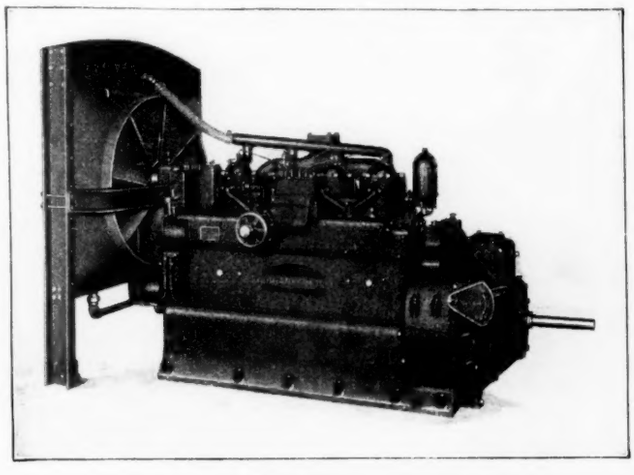


Fig. 3—A 60-hp. 800-r.p.m. unit with radiator cooling and built-in clutch

are mounted on the layshaft. When the lever-operated air starting valve is opened in the main air line, air is admitted to the passageway supplying the air starting valves. These valves are opened in proper sequence by the air starting cams.

Each cylinder has its injection pump, these pumps being mounted in a common housing at the right of the governor control wheel. Phosphor bronze is used for the pump cylinders, and the plungers and suction and discharge valves are all made of stainless steel.

The amount of fuel injected is controlled by the length of the injection-pump-plunger stroke and not by the closing of the suction valves. The suction valves are automatic in their operation; that is, they open and admit fuel to the barrel of the injection pump on the down stroke of the plunger. The length of stroke of the plunger is regulated through a simple linkage arrangement controlled by the governor. When the engine speeds up, the motion, caused by the lifting of the governor weights, is transmitted to the governor-control shaft. By referring to Fig. 1, it will be noticed that the plunger push rod is inclined at a slight angle, depending on the amount the eccentric strap has been moved to either side by the turning of the eccentric *C* on the governor-control shaft. When the push rod is moved to the left, as the result of an increase in speed, the vertical motion of the rocker when the cam passes under the roller is less than the previous lift of the push rod, and the length of stroke of the plunger is decreased.

A modification of these engines for commercial drives such as power shovels, consists in the use of radiator cooling and a built-in clutch. The radiator fan is belt driven from a pulley fastened to the forward end of the crankshaft and the circulating pump is also driven by a silent chain from a sprocket on the forward end of the crankshaft.

General Electric Atomic-Hydrogen Welding Outfit

BY THE use of atomic-hydrogen welding equipment recently brought out by the General Electric Co., Schenectady, N. Y., it is claimed that hitherto unwelding metals can be melted and fused without trace of oxidation and welding can be performed in some cases on metals as thin as paper. This process makes possible the welding of many special alloys and the production of ductile welds on iron and steel.

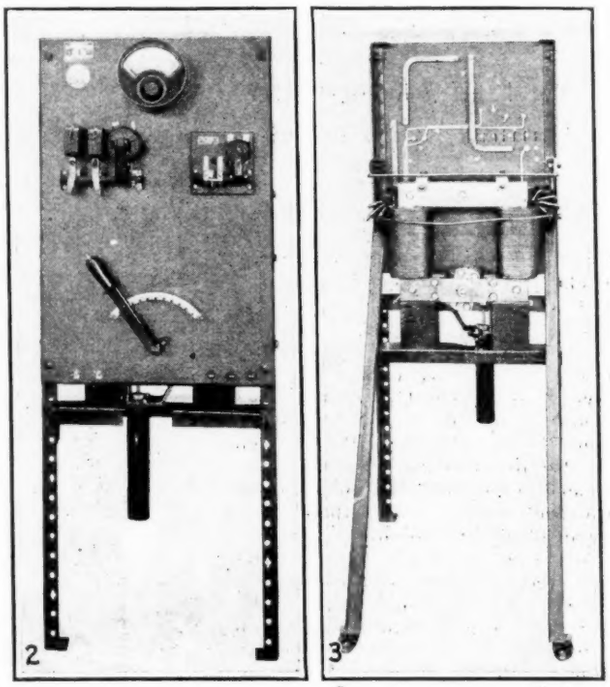
In brief, the method utilizes the passage of a stream of hydrogen through the arc between two electrodes. The heat of the arc breaks up the hydrogen molecules into atoms. These combine again a short distance beyond the arc into molecules of the gas, and in so doing liberate a large amount of heat, so that welding can be done more effectively. The atomic hydrogen is a powerful reducing agent so that alloys containing chromium, aluminum, silicon or manganese can thus be welded without fluxes and without surface oxidation.

The welding outfit consists of a welding torch, Fig. 1, and an instrument board, Figs. 2 and 3, on which are mounted a single-phase transformer for converting the voltage of a 60-cycle source of power to one suitable for the welding equipment and a specially designed variable reactor to provide the proper welding current and voltage for different classes of work.

The torch consists of a holder supporting two tungsten wire electrodes, the electric conductors connecting these electrodes to the reactor and the tubing for the hydrogen gas. Each electrode is supported inside a nozzle through which the hydrogen gas is forced out around the electrode. The combination of electrodes and nozzles is set at an angle and the distance between electrodes, or arc length, and also the flow of gas, are readily adjustable.

The electric conductors to and through the torch are heavily insulated and, when welding ceases, the welding circuit is automatically interrupted until such time as the operator is ready to weld again, when the circuit is automatically restored. There is no current flowing from the electrodes to the work to be welded. The circuit is completed from one electrode to the other.

The reactor consists of a U-shaped core provided with pole faces between which a pivoted armature is arranged to move. The legs of the core are provided with coils conected in series with the electrodes of the welding torch. The amount of welding current and voltage is governed by the movable armature which changes the air gap of the magnetic circuit and therefore the reactance. This armature is normally biased to an open position, and, upon a flow of current through the coils of the reactor, is attracted to a closed position that may be determined by means of a handle and a suitable mechanism. When the arc is struck the armature automatically assumes the closed position and remains there until welding ceases, when it automatically resumes the normal position of maximum air gap.



Figs. 2 and 3—Front and rear view of control panel

In making edge welds, the metal to be welded is melted under the heat of the arc but, when it is necessary to add more metal, a filler rod must be used and fed into the arc in much the same manner as is followed in ordinary gas welding.

The equipment is designed for operation from 60-cycle single-phase circuits only, and is recommended for use on ordinary metals less than $\frac{1}{4}$-in. in thickness, or on hitherto unweldable metals of greater thickness. It is stated that work as thin as 0.002 in. can be welded. One of the important claims made for atomic-hydrogen welding is that owing to the absence of oxides and nitrides from the weld, it is particularly adaptable to the welding of special alloys so far not weldable by other methods.

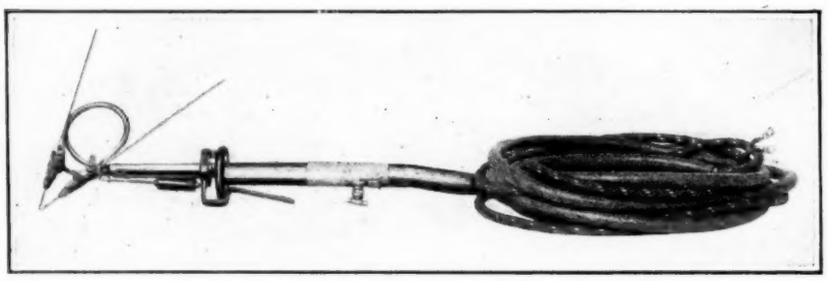


Fig. 1—Atomic-hydrogen welding torch

NEWS *of the* FIELD

A.I.E.E. Outlines Activities for West Coast Meeting

Members of the American Institute of Electrical Engineers attending the Pacific Coast convention of the Institute, which will take place at Del Monte, Calif., Sept. 13-16, will hear a number of valuable addresses and papers devoted principally to communication and high-tension transmission.

Studies will be offered at the student technical session, following registration Sept. 13, by representatives of California Institute of Technology, Stanford University, State College of Washington, University of Southern California, University of Utah and the University of Washington. The technical program for Sept. 14 includes four papers on telephone problems; the "Relation Between Frequency and Spark-Over Voltage in a Sphere-Gap Voltmeter," by L. E. Rukema, asisstant professor of electrical engineering, University of California; "The Space Charge that Surrounds a Conductor in Corona," by J. S. Carroll and J. T. Lusignan, Jr., respectively assistant professor of electrical engineering and graduate student, Stanford University," and "Electric Oscillations in the Double-Circuit Transmission Line," by Yoshio Satoh, Stanford University.

Harris J. Ryan to Speak

A general meeting will feature Wednesday evening, which Presidnet Bancroft Gherardi, who is chief engineer and vice-president of the American Telephone & Telegraph Co., New York, opens with an address. Dr. Harris J. Ryan, past-president of the A.I.E.E. and professor of electrical engineering, Stanford University, will then give his important paper on the "Possibilities of Future Electrical Development."

The topics to be considered at the technical sessions Thursday and those concluding the convention Friday, embrace transients due to short circuits, equipment for 220-kv. systems, static stability limits and the intermediate condenser station, synchronous, oscillographic recording apparatus for transmission lines, high-voltage oil circuit breakers for transmission lines, lightning protection for oil storage tanks and reservoirs, and lightning protection for oil tanks.

The Pit River hydro-electric system of the Pacific Gas & Electric Co. with its 220-kv. transmission, the Kings River project of the San Joaquin Light & Power Corp. with the Balch plant and its 2,381-ft. head, and the Big Creek-San Joaquin development of the Southern California Edison Co. with its several high-head plants and 220-kv. transmission, offer numerous possibilities for inspection trips. In addition, there are the transmission and distribution stations in the immediate vicinity of San Francisco Bay, the Ryan 2,100-kv. laboratory at Stanford, and other points of interest.

J. Q. Adams, Retiring Head of N. A. S. E., Dies Suddenly

John Quincy Adams, retiring president of the National Association of Stationary Engineers, died suddenly while returning from the forty-fifth annual convention of the Association at Los Angeles, during the afternoon of Aug. 28.

John Quincy Adams

Stopping with his wife and daughter and a party of engineers registered at the Hotel Whitcomb in San Francisco, Mr. Adams was suddenly stricken by acute indigestion, and died alone in his room, death thus terminating an active engineering career and a long period of useful service to his fellow members and officers of the Association.

At the age of 27 Mr. Adams became chief engineer of the passenger steamer "Iroquois," where he remained for two years. This was followed by service on different freight steamers and in 1910 he was made chief engineer of the palatial ocean-going yacht "Alvina." In the fall of 1911 this was sent to South American waters, where the winter of 1912 was spent. He remained with the "Alvina" on the Atlantic coast until the spring of 1913, when he returned to service on the Great Lakes.

In the spring of 1915 he was appointed chief Engineer and building superintendent of the St. Louis County court house at Duluth, in which capacity he remained till the end.

Shortly after receiving his appointment he became a member of Minnesota No. 3, N. A. S. E. of Duluth, where he has been one of the outstanding leaders of the state. He served as president of No. 3 for two years and president of the Minnesota State Association for two years.

President Adams was active in fraternal circles in the state, a thirty-third degree Mason, a member of the Duluth Chamber of Commerce and a member of the City Planning Commission.

Mr. Adams was Illustrious Potentate of the Shriners Temple at Duluth, and for fourteen years Venerable manager of the Lodge of Perfection.

He served also as financial secretary and was one of the organizers of the Duluth chapter of Marine Engineers.

Western A.S.M.E. Boys Meet for Seattle Gathering

Many engineers from western United States and Canada attended the Seattle sectional meeting of the American Society of Engineers which took place at the Hotel Olympic in that city, Aug. 30-31. Dean Dexter S. Kimball of Cornell University, president of the American Engineering Council contributed to the success of the gathering.

Among those who spoke at the sessions were G. S. Wilson, professor of mechanical engineering, University of Washington, H. J. McIntyre, assistant professor in the same subject at the university and W. L. Dudley, chief engineer and general manager of the Western Blower Co., Seattle. Performance data on centrifugal fans were presented.

In addition to the business sessions there were trips on the sound, an excursion to Olympic Peninsula, a theater party and an informal banquet and dance. Among the local engineers who sponsored the convention were: E. A. Eastwood, R. L. Rockwell, W. L. Newell, R. W. Raport, A. N. Walstad, C. E. Dole, F. H. Browning, W. L. Dudley, F. A. Rodgers, P. G. Johnson.

Investigation Looms

Persistent reports in The Capital indicate that every effort will be made to bring about a senatorial investigation of the growth and capitalization of public-utility companies as soon as the 70th Congress convenes.

N.A.S.E. in Action at Los Angeles Plans Activities and Reform Measures

Lively Forty-fifth Annual Meeting Pushes Educational Work and Consolidation —Finances Sound but Membership Off 2026—Recommendations Passed—Features Entertainment—New Officers Elected

TEN years of persistent effort by California engineers culminated in the holding of the forty-fifth annual convention of the National Association of Stationary Engineers in Los Angeles during the week of Aug. 22.

Headquarters were provided at the Hotel Ambassador, the auditorium of which was utilized for the display of exhibits, while the business sessions were held in the hotel's theater. The success of the meeting was largely credited by the 306 delegates and visiting engineers to the efficient and hospitable management of the convention committee. The scenic beauty of the locale, also enhanced the value and pleasure of the gathering.

After disposing of the usual formalities, registration and the addresses of welcome and response, the convention entered into the business of the meeting. In his annual report, National President John Quincy Adams reviewed the work of the year, emphasizing the importance of selecting efficient state deputies and of enlarging their functions, so that they may work in conjunction with the educational committee and education secretary for the success of the merit system.

Recommendations Discussed

From the complete tentative program for next year, prepared by the educational committee and published in the August issue of the *National Engineer*, Mr. Adams singled out some of the outstanding recommendations, among which was the sponsoring and publishing of an operating code book by the Association. He favored also the launching of a national employment bureau under the direction of the educational secretary, and recommended the appropriation of $10,000 equal to that of last year, for the maintenance of the work of the educational committee.

It was the president's conviction for the good of the order that small associations not holding regular meetings and not showing any inclination toward activity, should turn in their charters and that no charter should be issued to a new association having a prospective membership of less than twenty.

With certain exceptions the president favored elimination of exhibits at state

Vice-president Elmer Bassett and Wife in Line for Feed

conventions, as they are effecting patronage to the National Convention, and relative to the latter it was his conviction that the interests of the exhibitors and the engineers would be better served if the N.A.S.E. sponsored and promoted the show.

Elmer Bassett, national vice-president and deputy, showed a drop in membership from 19,819 in July of 1926 to 17,793 in the same month in 1927, indicating a net loss of 2,026, notwithstanding the fact that five new associations had been formed and that in 28 of the existing locals, gains ranging from 10 to 72 members had been made.

Financial figures made available showed funds on hand to the amount of $23,500, which was augmented by contributions of $14,596 from the convention committee and $1,500 from the contingency fund of the National Exhibitors' Association. The total thus showed $39,593 to defray running expenses and care for a convention mileage approximately 721,000 miles at a voted rate of 4½ cents per mile. Adding to the foregoing the anticipated income for the year to come, the board of directors forecast total receipts of $89,543, with disbursements amounting to $70,995, including $32,445 for present mileage, $10,000 to the Educational Committee, $2,000 to deputities, and numerous items necessary in the conduct of business. A balance approximating $19,000 should be available at the next convention to which would be added whatever receipts might be available from the mechanical exhibition.

Reports on Education

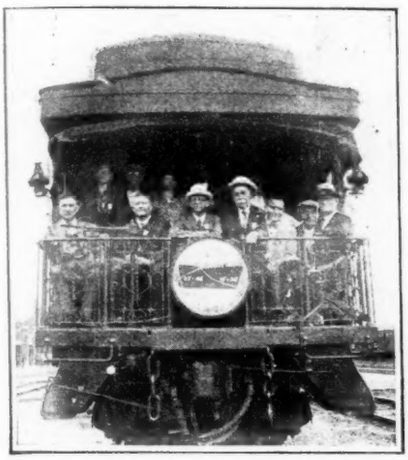
An analysis of the Merit work accomplished during the year by the National Educational Committee showed the sale of 510 Merit books, 300 technical students, 125,000 technical questions submitted for grading, and the issuance of 45 technical and 230 practical certificates. Of various things accomplished, a course in safety engineering had been substituted for the mechanics and hydraulics course, the electrical course had been rewritten, a power-plant costs course had been prepared to add to the Merit book, and it was recommended that the present course in hotels and buildings be revised to include problems in building management.

On Top of Pike's Peak

The report of the Information Service Committee referred to the numerous questions that had been answered and the beginning of a compilation of an operating code to be published in sections so that it might be available sooner to the membership.

Members and Friends of the National Association

In its report the board of trustees of the *National Engineer* reviewed at length the business situation confronting the paper and the necessity of furnishing the service that the industrial advertiser has come to expect, such as the preparation of advertising copy, an analysis of the buying power and a classification of the membership. To this end a service and statistical bureau was proposed. Circulation is to be increased



Santa Fe,—"Bassett's Special"

by taking subscriptions to the paper outside the association.

During the convention considerable discussion was devoted to the forgoing aspects, the loss of membership, ways and means of increasing interest in the Merit system and to the possibility of the engineers operating their own show. When the last named question at issue was put to a vote, the motion was lost.

The report of the Life and Accident Insurance Department showed a net membership on Aug. 1, of 3,066, payment of 69 claims during the year and the following balances: Benefit fund, $212.09; expense fund, $1,886.68; reserve fund, $12,620.67.

Throughout the meeting a number of illustrated talks had been arranged. J. M. Gaylord and Walter G. Blossom, engineers of the Southern California Edison Co. gave interesting addresses, the former on "Hydro-Electric Development in the High Sierras," and Mr. Blossom on the "Romance of Electricity," which was illustrated with motion pictures showing the company's activities in the Big Creek and Huntington Lake regions. William Mullholland, builder of the Los Angeles aqueduct, related the history of the city's water supply system and its construction together with a number of interesting side lights on the early history of Los Angeles. H. A. Matier pictured the story of California's oil development.

Entertainment offered was of the well-known California variety, consisting of an informal reception by National officers to the delegates at the Ambassador, a Spanish barbecue dinner at the Belmont Club at Long Beach, an excellent program of entertainment offered by the National Exhibitors' Association, open house by California No. 2, automobile tours and entertainment for the ladies and as the closing event, the public installation of officers and the Grand Ball at the Ambassador Hotel.

New Officers Elected

Officers elected for the coming year were: Elmer L. Bassett, national president; Thomas R. Herlihy, national vice-president; Fred W. Raven, national secretary; Samuel B. Forse, national treasurer; W. J. Reynolds, national trustee for five years; George Armitage, national conductor; C. A. Nelson, doorkeeper.

Detroit was chosen as the next convention city.

The mechanical exhibit this year was one of the best in the history of the organization. Arrangement of equipment and the decorative features made a most attractive display. The number of exhibitors was relatively small, 127, using 144 booths, but the financial returns, owing to the higher rates charged for the booths, far exceeded all past records and made possible a contribution to the association exceeding $14,000. Much of the credit for the success of the show was due to the aggressiveness of the local committee and the efficient character of their work. For a community of comparatively small industrial development, the attendance was excellent, coming as it did in large part from the oil industry.

Officers of the National Exhibitors' Association for the coming year are: President, Jacob Eige, Fisher Governor Co.; vice-president, I. S. Pieters, Plibrico Jointless Firebrick Co.; treasurer, Fred Jolley, Jenkins Bros.; executive committee, G. T. Ogden, John H. Allen, John W. Troescher, H. A. Burdorf and W. H. Gaylord. F. N. Chapman was reappointed secretary.

Plans for New York Power Show Now Well Ahead

The sixth National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York City, Dec. 5 to 19 inclusive, coincident with the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers. Numerous other organizations will meet at the same time; some of these will meet jointly with, or in bodies attend the exposition.

Exhibitors this year are already reported considerably increased over last year. There are now more than 500 exhibitors, and the displays will include approximately some 400 specimens of power generation, distribution and utilization; between 200 and 250 exhibits will include heating and ventilating equipment, and refrigeration for large-scale industries, factories, office buildings, apartment, public and assembly buildings and homes.

One hundred and fifty exhibits will show instruments for control of time, pressure, temperature, volume or what other element requires precision in its measurement or recording. There will be about 125 exhibits or more of machine-shop equipment, including metal- and wood-working machines, transmission equipment, tools and machine tools, and in this phase of the exposition's activities, there has been a marked increase in number of exhibits. There are many new outstanding exhibits of transmission equipment and numerous exhibits of materials handling equipment. Mechanical exhibits of all kinds will lead the way to the complete equipment of every industrial plant.

Many unusual educational booths are planned for a large attendance of representative engineers, manufacturers, technical men, construction men, and plant and building operators.

of Stationary Engineers Attending Forty-fifth Convention

The advisory committee of the exposition co-operating with the management comprises: I. E. Moultrop, chairman; Homer Addams, F. Paul Anderson, N. A. Carle, Willis H. Carrier, Fred Felderman, C. F. Hirschfeld, O. P. Hood, John A. Hunter, E. B. Katte, R. T. Kent, John H. Lawrence, Fred R. Low, David Moffatt Myers, R. F. Pack, Fred W. Payne, Calvin W. Rice, Charles F. Roth and Charles M. Schwab.

The managers report that the exposition will this year occupy four full floors of the Grand Central Palace and that, excepting a few spaces still available, all space is engaged. All inquiries should be addressed to the International Exposition Co. at the Grand Central Palace, New York City.

Personal Mention

H. J. BLANTON recently joined the engineering department of the Ladd Water Tube Boiler Co., Pittsburgh.

VICTOR J. AZBE, chairman of the St. Louis Section of the American Society of Mechanical Engineers has been spending some months of study in Europe.

H. H. NEEHAM is now with the hydraulic department of the Allis-Chalmers Manufacturing Co., Milwaukee, having severed his association with the American Trading Corp. at Tokyo, Japan.

Prof. A. S. LANGSDORF, of the new Industrial Research Department at Washington University, has returned from Cambridge, Mass. He taught on the summer school instruction taff of Massachusetts Institute of Technology.

GEO. R. PRATT, of late fuel engineer for the government of Alberta, announces that he has established himself in private practice as consulting fuel and mechanical engineer at 117 Phoenix Bldg., Donald St., Winnipeg, Canada.

H. HARRISON, mechanical engineer with the Brunswick-Kroeschell Co., manufacturers of refrigerating and ice-making machinery and power and heating boilers, New Brunswick, N. J., has been appointed general sales manager for the company.

S. LOGAN KERR, assistant chief engineer for the I. P. Morris Corp., Philadelphia, sails for Europe Sept. 8., and after spending a week with the American Legion will take an extended trip through France, Switzerland, Germany and Sweden to study power plant practice and conditions in those countries.

CLAUDE C. BROWN, mechanical and electrical engineer, formerly gas engineer for the California Railroad Commission for the past four years, is now gas administrator for Southern California. For many years previously Mr. Brown was connected with a number of the larger electric and gas utilities and industrial developments in California.

PROFESSOR BLAKE R. VANLEER, elected to the Berkeley City Council Calif., last May, has tendered his resignation in order to study in Europe under the John R. Freeman scholarship plan of the American Society of Mechanical Engineers.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Refractories Institute will hold its fall meeting Thursday, Sept. 15, at the Clifton Hotel, Niagara Falls, Canada.

American Water Works Association. California Section, at San Jose, Oct. 5-8; Paul E. Magerstadt, sec., East Bay Water Co., Oakland; Central States Section will hold annual meeting at Akron, Ohio, Sept. 15-16; E. E. Bankson, sec., Union Bank Building, Pittsburgh. North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill; Southwest Waterworks Association will meet at Hot Springs, Ark., Oct. 10; Lewis A. Quigley, sec., superintendent of City Waterworks, Fort Worth, Tex. Iowa Section, at Council Bluffs, Hotel Chieftain, Sept. 28-30; Jack J. Hinman, Jr., secretary, P.O. Box 313, Iowa City.

American Welding Society, fall meeting at Book Cadillac Hotel, Detroit, Sept. 19-23.

Association of Edison Illuminating Co's, convention at Colorado Springs, Col.; Sept. 26-30.

Empire State Gas and Electric Association, meeting at Lake Placid, N. Y.; Oct. 6-7.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Fuels Meeting, under the auspices of the Fuels Division of the American Society of Mechanical Engineers, will be held Oct. 10-13 at St. Louis, Mo.

New York Power Show (National Exposition of Power and Mechanical Engineering) will be held at the Grand Central Palace, New York City, Dec. 5-10. Address inquiries to the International Exposition Co., Grand Central Palace.

G. F. MOORE, manager of Parkin Power & Light plant, has been appointed manager of the Earle power and light plant, Ark. Mr. Moore's appointment was due to the resignation of C. F. Morrison of Earle. Mr. Moore is a graduate of the electrical engineering department of Arkansas University.

FREDERICK M. GIBSON, for the past seventeen years plant engineer of the American Sugar Refinery Co. at Boston, has been appointed engineer in charge of improvements to be made at the Brooklyn, N. Y., plant of the company, with headquarters at Brooklyn. His successor at Boston will be W. E. Kimball, who has been assistant plant engineer for some years. Mr. Gibson is a past chairman of the Plant Engineers Club of Boston and has been active in the Affiliated Technical Societies of Boston since the inception of that organization.

K. M. WHITE, who has completed a summer connection on Power's editorial staff, joined the engineering department of the Kaestner & Hecht Co., manufacturers of electric elevators, Chicago. Mr. White assumes his new duties Sept. 8.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous	Market	Aug. 31
Net Tons	Quoting	1927
Pool 1	New York	$2.50@$2.75
Smokeless*	Boston	4.25@ 4.40
Clearfield	Boston	1.60@ 1.90
Somerset	Boston	1.70@ 2.00
Kanawha	Columbus	1.50@ 1.75
Hocking	Columbus	2.00@ 2.25
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.25@ 1.50
Franklin, Ill	Chicago	
Central, Ill	Chicago	
Ind. 4th Vein	Chicago	
West Ky	Louisville	2.25@ 2.50
S. E. Ky	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.75@ 2.00

*Gross tons f. o. b. vessel, Hampton Roads.

Anthracite		
Gross Tons		
Buckwheat No. 1.	New York	2.50@ 3.00
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	1.60@ 1.85

FUEL OIL

New York—Aug. 31, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 5¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis — Aug. 24, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.625 per bbl.; 26@28 deg., $1.675 per bbl.; 28@30 deg., $1.725 per bbl.; 30@32 deg., $1.775 per bbl.; 32@36 deg., gas oil 4.35c. per gal.; 38@40 deg., 4.98c. per gal.

Pittsburgh—Aug. 30, f.o.b. local refinery; 30@34 deg., fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5c. per gal.

Philadelphia—Sept. 1, 26@30 deg., $2@$2.06 per bbl.; 13@19 deg., $1.68@$1.74 per bbl.; 22 plus, $1.79@$1.85; 27@30, $2.10@$2.16.

Cincinnati—Aug. 29, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

Chicago—Aug. 20, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 24@26 deg., 95c. per bbl.; 26@30 deg., 97½@$1.00; 30@32 deg., $1.05.

Boston—Aug. 29, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.25c. per gal.; 28@32 deg., 5.75c. per gal.

Dallas—Aug. 27, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

Business Notes

THE BLAW-KNOX Co.'s New York office moves to 342 Madison Ave., Oct. 1. plete installations.

THE BROWN INSTRUMENT Co., Philadelphia, has established a new branch office at Kansas City, Mo. Territory covered by this office includes the States of Kansas, Nebraska, the western part of Missouri and the city of Council Bluffs, Iowa. F. M. Poole will be district manager in charge. The address of the new office is 509 Mutual Building.

THE STANDARD POWER EQUIPMENT CORP., St. Louis, Mo., has been incorporated by H. L. Bills and Frank H. Schubert for the manufacture of all types and sizes of cooling towers. The firm handles a complete line of power-plant equipment, representing also the Riley Stoker Corp., Brunswick-Kroeschell Co., D. Connelly Boiler Co., Ellison Draft Gages, Frederick Pumps, and other interests.

Trade Catalogs

INSULATION PRODUCTS FOR HOT AND COLD SURFACES — The Ehret Magnesia Manufacturing Co., Valley Forge, Pa., offers in the new A-26 catalog a complete treatise on insulation products for all hot and cold surfaces, including equipment carrying high temperatures prevalent.

CENTRIFUGAL BLOWERS AND COMPRESSORS—The Elliott Co., Jeannette, Pa., has issued bulletin "P" on centrifugal blowers and compressors using high speeds and open radial impellers. In addition to construction details, the bulletin includes technical information and curves for figuring blowers sizes and capacities.

STEAM JET EXHAUSTERS AND COMPRESSORS — The Schutte & Koerting Co., Philadelphia, in Bulletin No. 4-E describes jet exhausters and compressors designed on the jet principle, using live steam or compressed air as the operating medium. Built to operate at moderately high vacuum, these exhausters can be used in a great many ways for power plant and industrial plant service.

HEAT SAVING EQUIPMENT—The Heat-Cop Corp., manufacturers of Heat-Cop systems, Mutual Building, Richmond, Va., in a special booklet, "A Word to the Wise", describes a heat-saving system particularly adapted to the low pressure heating field.

STEAM JET ASH CONVEYORS—The Conveyors Corporation of America has issued a catalog on steam jet ash conveyors. This conveyor operates on the principle of a steam jet which conveys the ash through a pipe line from the ash-pit door to suitable receptacles, storage tanks or other points of discharge. The features claimed for it are simplicity and operating economy. This catalog describes the latest refinement of design in the American Steam Jet Ash Conveyor and illustrates the fittings and equipment necessary for complete installations. It contains a number of installation photographs and diagrams on method of application to various types of boiler.

NEW PLANT CONSTRUCTION

Ark., Conway—Bids until Sept. 8 for improvements to sewage treatment plant including pump house, etc. (Power 1)

Calif., Los Angeles—Contract has been awarded for the first unit of a produce terminal. Estimated cost $1,500,000. Total estimated cost $3,500,000. (Power 2)

Calif., Los Angeles—Preliminary plans prepared for the construction of a 13 story apartment including steam heating system, etc. Estimated cost $1,500,000. (Power 3)

Calif., San Francisco—Plans to be made for a fruit distributing plant including refrigeration plant. Estimated cost $150,000. (Power 4)

Calif., Ventura—Preliminary plans prepared for the construction of a group of buildings including steam heating and refrigeration systems, swimming pool, etc. Estimated cost $600,000. (Power 7)

Fla., Ocala—Election Sept. 6 to vote $150,000 bonds for the construction of an electric light plant. (Power 5)

Ill., Belleville—Bids will soon be asked for the construction of a 6 story hotel including steam heating system, etc. Estimated cost $500,000. (Power 74)

Ill., Chicago—General contract has been awarded for a 17 story apartment. Estimated cost $3,000,000. Heating, plumbing, elevators, etc. to be awarded later. (Power 6)

Ill., Chicago — Contract awarded for masonry, etc. for a 13 story apartment building. Estimated cost $1,000,000. (Power 12)

Ill., Chicago—Plans are under way and bids will be taken about Sept. 23 for a 13 story hotel and stores building including swimming pool, elevators, etc. Estimated cost $1,000,000. (Power 8)

Ill., Chicago—Contract has been awarded for the construction of a 27 story apartment building. Estimated cost $2,500,000. Refrigeration system will be installed. (Power 9)

Ill., Chicago—Taking bids for the construction of a 15 story apartment. Estimated cost $2,000,000. (Power 10)

Ill., Chicago—Plans are under way for a 7 story hotel including elevators, etc. Estimated cost $500,000. (Power 11)

Names and addresses of the responsible parties in charge of the projects listed on this page are available to our readers, and will be furnished upon application. The editors have omitted this information from the current issue for the purpose of measuring the value of our equipment-wanted items and new plant construction reports as a regular feature of the paper. Address

A. W. Welch,
Power Information Bureau,
Tenth Ave. at 36th St.,
New York, N. Y.

Ill., Lawrenceville — Plans the construction of a steam power plant. Estimated cost $40,000. H. K. Harshberger, is chief engineer. (Power 75)

Ind., Anderson — Contract has been awarded for a new boiler room at the water and light plant. Estimated cost $62,000. (Power 13)

Ind., Gary—Contract awarded for the construction of a 7 story hotel. Estimated cost $500,000. (Power 76)

Ia., Iowa City—Bids until Sept. 9 for addition to heating plant. Estimated cost $160,000. (Power 14)

Kan., Chetope—$35,000 bonds have been voted for improvements to electric light plant. (Power 53)

Ky., Murray—Contract has been awarded for a heating plant. Estimated cost $44,798. (Power 15)

La., Anoanasa — Plans the construction of a steam operated electric power plant to replace fire loss. Estimated cost $85,000. (Power 77)

La., Baton Rouge—Plans are under way for the construction of a new pumping plant. Estimated cost $35,000. (Power 84)

La., Shreveport—Bids will probably be taken in October for a sewage pumping station. (Power 17)

Maryland—Plans have been approved for a new central power plant and a central heating plant. Total estimated cost $581,000. (Power 18)

Md., Baltimore—Plans are under way for the construction of a power house. Estimated cost $150,000. (Power 78)

Md., Baltimore—Plans are under way for the construction of a new pumping station for waterworks in Guilford District. (Power 79)

Mass., Arlington (Boston P.O.)—Preliminary plans underway for an electric sub-station. (Power 19)

Mass., Beverly—Bids have been received for the superstructure of a pumping station, inlet, sewers, etc., lowest bid $27,600. (Power 21)

Mass., Borton—Plans are being made for a new power plant. (Power 22)

Mass., Brighton (Boston P.O.)—Plans have been completed for an ice manufacturing plant, estimated cost $40,000. (Power 23)

Mass., Dorchester (Boston P.O.)—Contract has been awarded for a hospital building and boiler house. Estimated cost $250,000. (Power 24)

Mass., Somerville (Boston P.O.)—Contract has been awarded for a boiler house and heating plant for Highland Ave. School. Estimated cost $62,000. (Power 25)

Mass., West Springfield (Springfield P.O.) —Plans have been prepared for the construction of a power plant here. (Power 26)

Mich., Birmingham—Sketches are being made for an 8 story office building including steam heating and ventilation systems, boilers, elevators, etc. Estimated cost $1,000,000. (Power 27)

Mich., Detroit—Plans have been prepared for a 16 story mercantile building including steam heating and ventilation systems, boilers, elevators, etc. (Power 28)

Mich., Detriot — Preliminary plans are under way and bond issue to be voted upon to supply $641,000 for new water supply system including pumping station, filtration plant, etc. (Power 58)

Mich., Detroit—Plans for the construction of a 6 story office building including steam heating system, etc. at Clinton and Raynor Sts. Estimated cost $1,000,000. (Power 16)

Mo., Kansas City—Will build a 10 story hotel by day labor. (Power 51)

Mo., Carthage—Plans are underway for addition to power plant and waterworks, 1200 hp. Diesel oil engine, 1,000,000 gal. tank on tower, etc. Estimated cost $50,000. Work will be done by day labor. (Power 29)

Mo., Ironton—Bids early in 1928 for waterworks improvements including well, 100,000 gal. reservoir, pump house, plunger type pump, etc. Estimated cost $90,000. (Power 31)

N. J., Jersey City—Plans are under way for the construction of a distribution plant. Estimated cost $150,000. (Power 80)

N. J., Bradley Beach—Plans completed for alterations and construction of a new 6 story addition to hotel and apartment including steam heating, refrigeration and ventilation systems, boilers, elevators, etc. Estimated cost $1,000,000. (Power 37)

N. J. Newark—Plans prepared for the construction of a 6 story hospital including steam heating and ventilation systems, boilers, elevators, etc. at 9th Ave. and 9th St. Estimated cost $500,000. (Power 20)

N. C., Goldsboro—Contract awarded for the construction of a pumping station. Estimated cost $27,000. (Power 54)

O., Apple Creek — Plans have been prepared for the construction of a power house for Institution for Feeble Minded. Estimated cost $60,000. (Power 55)

O., Cincinnati — Plans have been completed for the construction of a group of power sub-stations. Estimated cost $75,000. (Power 59)

Okla., Foxon—Contract will soon be awarded for waterworks improvements including well, pump and motor, etc. Estimated cost $15,000. (Power 38)

Okla., Marshall—Election Sept. 14 to vote $18,000 bonds for waterworks improvements including new well, pump and motor, mains, etc. (Power 56)

Pa., Allentown—Bids will soon be asked for the construction of a 70 x 70 ft. power house. Estimated cost $40,000. (Power 81)

Pa., Bethlehem—Contract has been awarded for a 46 x 80 ft. power house. (Power 39)

Pa., Philadelphia—Bids until Sept. 9 for the construction of a 13 story office building including steam heating system, elevators, etc. Estimated cost $1,000,000 (Power 40)

Pa., Philadelphia—Bids were opened Sept. 6 for a 60 x 80 ft. sub-station. (Power 41)

Pa., Philadelphia—Plans the construction of a 5 or 6 story apartment, stores and office building on Germantown St. (Power 30)

Pa., Pittsburgh—Plans are under way for the construction of a 36 story office building. Estimated cost $8,500,000. (Power 85)

Pa., Sewickley—Sketches made for the construction of a 3 and 5 story hospital. Estimated cost $1,000,000. (Power 42)

Pa., West Monroe—The Ouachita Ice & Fuel Co. is having plans prepared for the construction of an ice and cold storage plant. Estimated cost $45,000. G. E. Wells, Security Bldg., St. Louis, Mo., is consulting engineer. (Power 82)

R. I., Providence—Bids until Sept. 12 for the construction of a pumping station, cost $40,000. (Power 42)

S. D., Rapid City—Plans prepared for the construction of a 9 story hotel including vacuum heating and ventilation systems, elevators, etc. Estimated cost $750,000. (Power 32)

Tex., Austin—Revised plans prepared for the construction of a 10 story office building including steam heating system, elevators, etc. at 8th St. and Congress Ave. Estimated cost $500,000. (Power 33)

Tex., Dallas—Franchise has been granted for the construction of a 1000 ton capacity per day ammounia refrigeration plant. Estimated cost $1,000,000. (Power 43)

Tex., Fort Worth—Contract has been awarded for first of three units of a hospital. Total estimated cost $1,500,000. (Power 44)

Tex., Houston—Bids will soon be called for the construction of a terminal warehouse. Estimated cost $1,000,000. (Power 45)

Tex., Galveston—Plans prepared for the construction of an 11 story office building at Mechanic and 21st Sts. (Power 36)

Tex., Odessa—Work has been started on a new steam operated electric generating plant, also a transmission line for service in oil fields. Estimated cost $250,000. (Power 83)

Tex., Remount—Surveys will be made for a dam across White Rock Creek to divert 20,000 acre ft. of water annually from the junction of the Brazos and Bosque Rivers, a pump station will be built at the junction of the two rivers, to divert water to the reservoir. Estimated cost $150,000. (Power 46)

Tex., Sweetwater—Election Sept. 19 to vote $750,000 bonds for waterworks improvements including dam, 2260 ft. long and 70 ft. high, pumping unit, etc. (Power 47)

Tex., Welasco—Bids will soon be called for the construction of a hotel. Estimated cost $500,000. (Power 34)

Tex., Waco—Contract awarded for the construction of a 12 story hotel. Estimated cost $700,000. (Power 35)

W. Va., Grantsville—Plans for the construction of a new steam operated electric generating plant. Estimated cost $45,000. (Power 60)

Ont., Hamilton—Plans are underway for waterworks improvements including reservoir, pumping station, etc. Estimated cost $800,000. (Power 48)

Ont., Thorold—Contract will soon be awarded for waterworks improvements including pumping station, electric centrifugal pumps, etc. Estimated cost $80,000. (Power 49)

Ont., Toronto—Plans are under way for the construction of a paperboard mill including boiler plant, engine building and pump room. Estimated cost $500,000 (Power 50)

Ont., Toronto—Contract has been awarded for the first unit in the $2,500,000 hospital extension program. (Power 52)

Que., Ste. Julienne — Bids will soon be called for development of Mangan Falls on Quareau River including power houses, dams, etc. Estimated cost $1,500,000. (Power 57)

Equipment Wanted

Boilers, Pumps, Motors, Etc.—Will be in the market for pumps, motors, boilers, etc. for proposed paperboard mill (Power 61)

Diesel Engine and Generator—Diesel engine and generator, 600 hp. capacity for electric light plant. (Power 62)

Electric Hoist—1,000 lb. capacity and single or three ph., 60 cycle, a.c. motor. (Power 63)

Fire Pumps, Etc.—Fire pumps, etc. for proposed waterworks improvements. (Power 64)

Engine, Etc.—Diesel oil engine, 1,200 hp. capacity for proposed improvements to power plant and waterworks. Estimated cost $50,000. (Power 65)

Pumps—Bids until Sept. 12, for pumps, etc. for proposed sewage treatment plant. (Power 68)

Pumps, Etc.—Bids until Sept. 12, for two 500 g.p.m. centrifugal pumps, etc. for proposed waterworks improvements. (Power 69)

Pumps, Etc.—Bids until Sept. 27, for a 1,000 g.p.m. electrically driven centrifugal pump, etc. for proposed filter plant. (Power 70)

Pump and Motor—Deep well pump and motor for proposed waterworks improvements. (Power 71)

Pump and Motor—Horizontal duplex pump and electric motor. (Power 66)

Pumping Equipment—For three wells and distribution mains. (Power 67)

Pumping Equipment—Bids until Sept. 27, for furnishing and installing low lift pumping equipment. (Power 72)

Pumps — Bids until Sept. 21, for two 4,200 g.p.m. domestic service pumps, two 4,200 g.p.m. fire service pumps and one 750 g.p.m. wash water pump, etc. for proposed waterworks improvements. (Power 73)

Pumps, Motors, etc.—Bids until Sept. 12 for one 80 g.p.m. single stroke pump, one 100 g.p.m. double stroke pump, one 15 hp. automatic start motor, 3 ph., 60 cycle, 220 v. 120 r.p.m., etc., for proposed waterworks. Estimated cost $15,000. (72)

A. W. WELCH,
Power Information Bureau
Tenth Avenue at 36th St.
New York, N. Y.

Send me names and addresses of the responsible parties having charge of the following projects listed this week:

Numbers .....

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Name .....

Company .....

Address .....